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ROTOR DRONE PRO

VOLUME 8, NUMBER 6 | DECEMBER 2021/JANUARY 2022

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ROTOR DRONE PRO

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ON THE COVER:
No matter your adventure, you'll find the perfect drone in this month's "Five Best Buys" guide. (Photo by Luka Svetik via Shutterstock)

PREVIOUS PAGE:
Don't miss the latest in UAV technology in our coverage of Xponential 2021. (Photo by Patrick Sherman)

THIS PAGE:
Looking for a new camera drone? See how the DJI Air 2S stacks up against other aircraft in "Five Best Buys." (Photo by Patrick Sherman)

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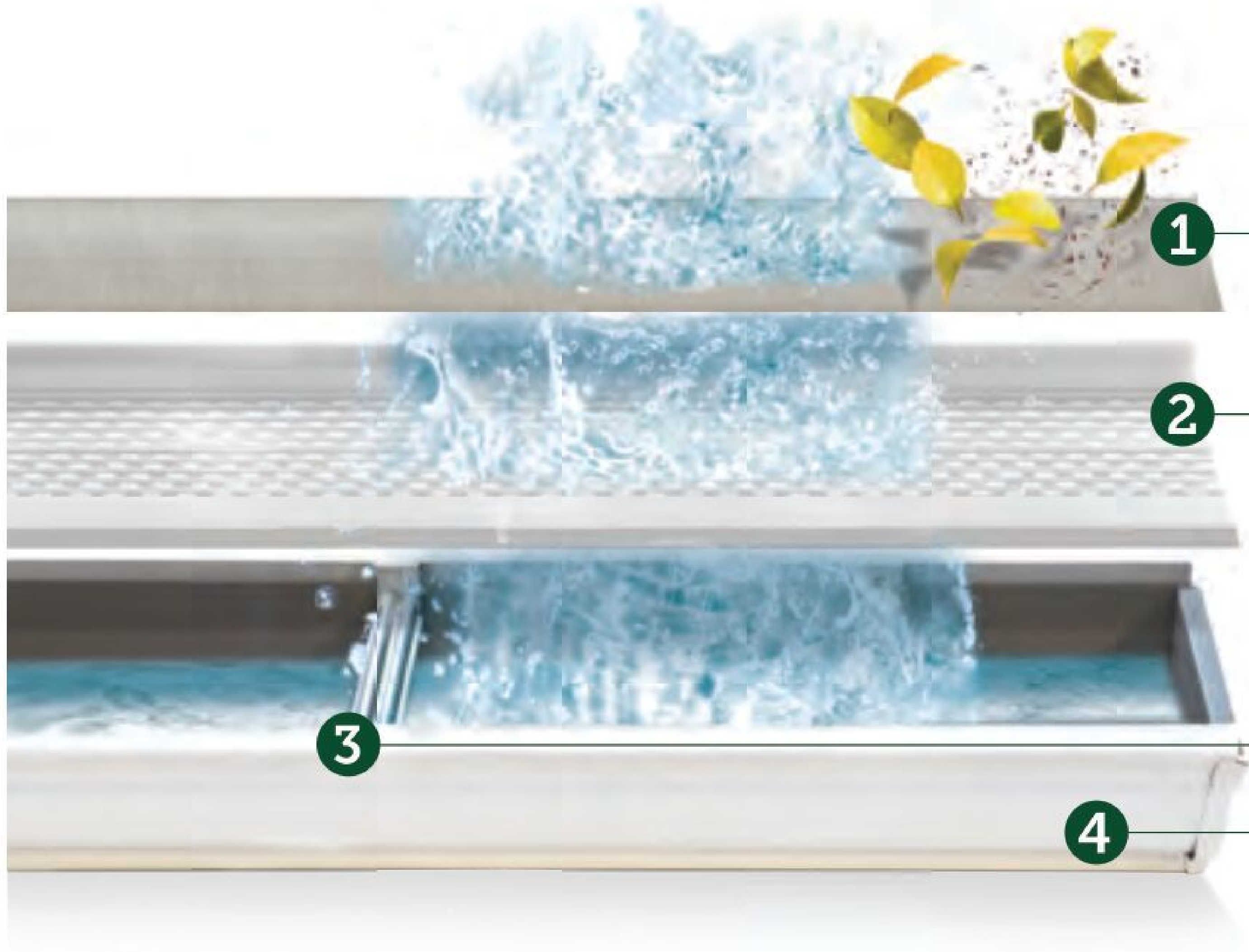
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BY DEBRA CLEGHORN

IT'S TIME FOR A NEW ADVENTURE

This issue's "Five Best Buys" feature is just what you've been looking for to get into the great wide open. Our experts have carefully selected the best drones for the hobbyist or the professional. If you're documenting your vacation, we have a perfect $500 travel-ready mini-drone for the aspiring photographer. Looking for a rugged airframe with thermal imaging and 32x zoom capability for public safety work? The Parrot Anafi USA is a $7000, weather-proof, military grade drone for professional and commercial use. And we've also got you covered if you're looking for something in between. "Five Best Buys" takes the guesswork out purchasing your next drone so you can get started on your next big adventure.

Speaking of getting out there, *RotorDrone Pro* contributor Patrick Sherman attended this year's Xponential event in Atlanta (which marked the return of in-person drone technology shows!). One of the largest and most comprehensive trade shows for uncrewed aerial systems, Xponential is where many drone and tech companies unveil their latest equipment, software, and accessories, and this year's event did not disappoint. Check out "Xponential 2021" for a sneak preview of the latest tech that's headed our way.

I hope you enjoy this December 2021/January 2022 issue and continue to send comments on articles, questions you'd like to see answered, and how you use uncrewed aircraft to RotorDrone@AirAge.com. Your feedback helps us continue to make *RotorDrone Pro* the industry's premier drone magazine.

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We love hearing from our readers. Your emails, tweets, and comments let us know what you'd like to see in print and online. Here's what some of you are saying about *RotorDrone Pro*.

RotorDronePro.com › Mailbag

When the Parrot Anafi USA was announced last summer, I thought that it might be a perfect fit as a tool for my house inspection business and for my volunteer search-and-rescue work. The integrated FLIR camera and 32x zoom lens, as well as the ability to fly in windy and rainy conditions, are especially important for remote field work. I have held off on purchasing it because with a $7,000 price tag, it needed to really be worth the investment. Then I read Patrick Sherman's review of the Anafi USA in the October/November issue of *RotorDrone Pro*. His in-depth writeup—and especially the zoom images in action—made me realize that it was time to make the order. I read every issue of *RotorDrone Pro* and learn something every time; thank you for the great work!
Lance Beaumont [email]

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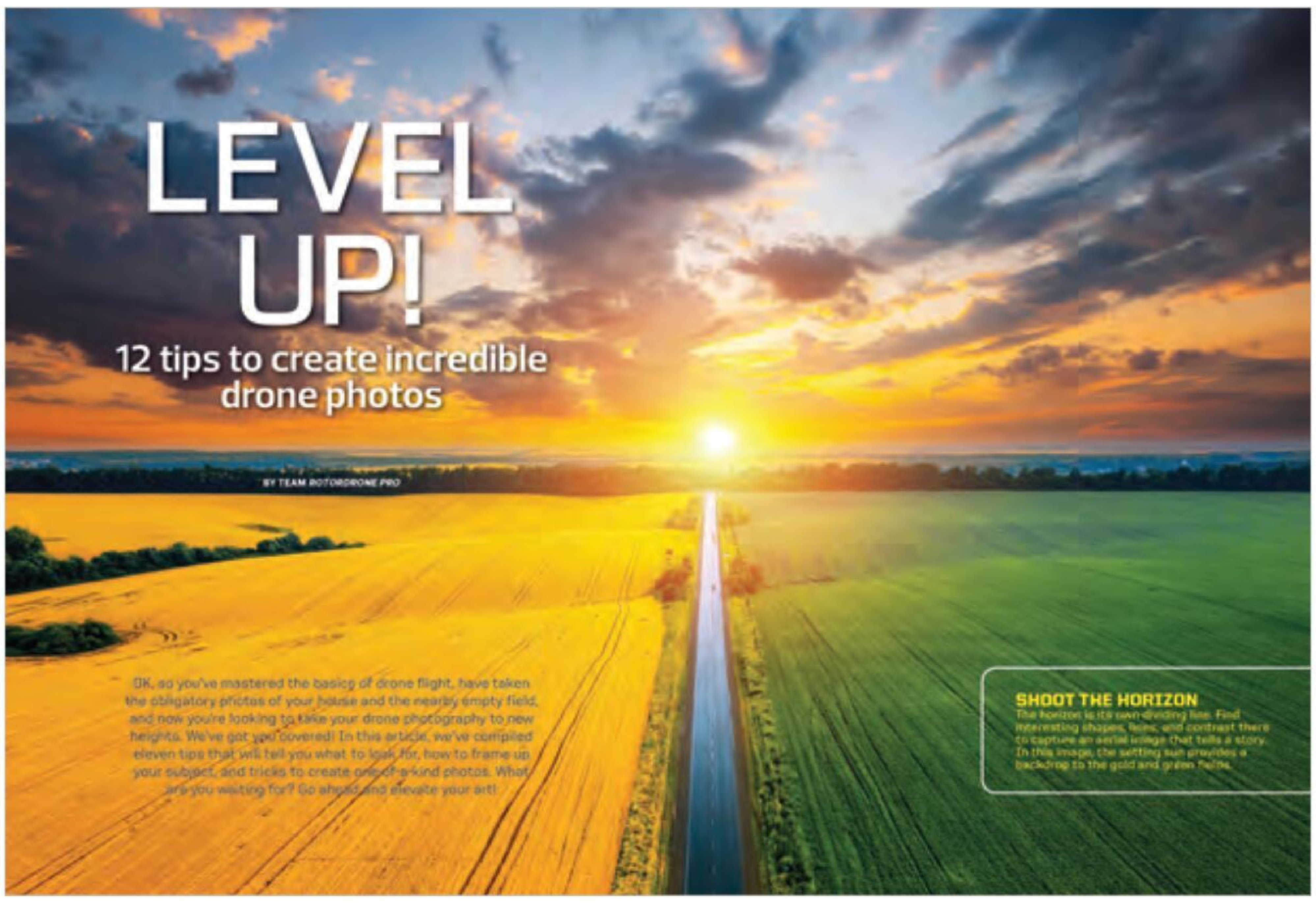
Remote-Split Operations 101
THE RIGHT TOOL FOR THE JOB
LIDAR vs. Photogrammetry

RotorDronePro.com › Mailbag

I am an aspiring amateur drone photographer and look at the photos in *RotorDrone Pro* and wonder "How did they do that?" The "Level Up! 12 Tips to create incredible drone photos" feature in the October/November 2021 issue had some practical advice that has already helped me to take better and more interesting aerial images. Thanks for remembering us newbies!
Stacey Birch [email]

As a new Mavic Mini owner, your feature article, "Level Up!" in the last magazine spoke to me. Your tips and beautiful images inspired me to pursue aerial drone photography. Thank you so much for sharing these easy tips and tricks that I know that will help me in the near future.
Simon G. [email]


LEVEL UP!
12 tips to create incredible drone photos
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Facebook › Close Encounter

When a friendly southern right whale swam close to a local paddleboarder off the coast of Puerto Madryn, Argentina, a drone was in the right place at the right time to capture the encounter. The whale even gently nudged the boat with its right fin. We shared the footage and here's what you had to say:

***Mike S.:** Really cool and a great experience. Glad it was a gentle giant and not a shark!*

***Chris Tucker:** The paddleboarder looks calm. I would have been freaking out!*

***AJ Harris:** : Incredible! I'm not sure if I'd rather be the person on the boat or the drone operator—amazing either way!*

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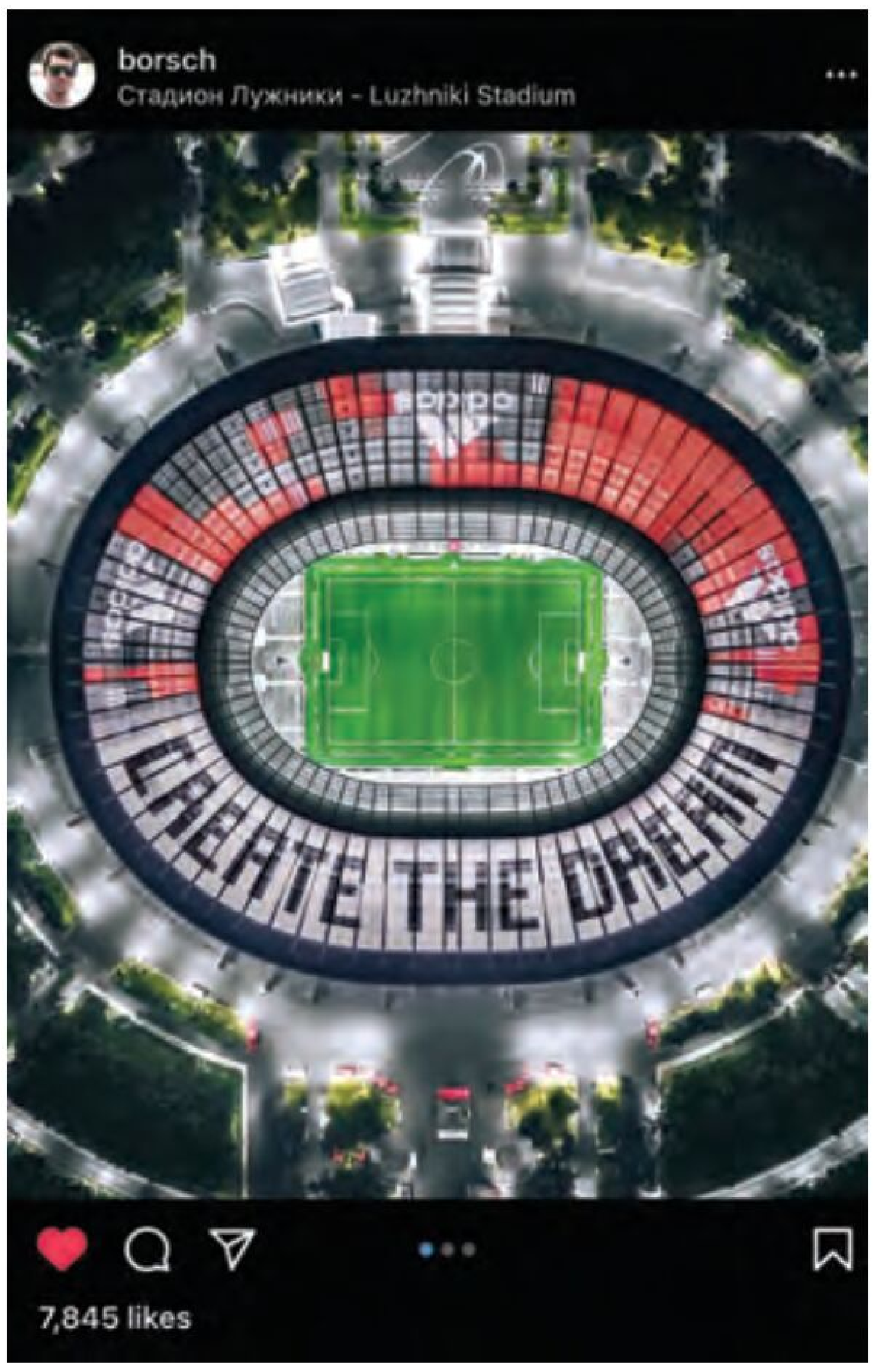
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Public Safety Drones
DRONERESPONDERS Survey Results

BY PATRICK SHERMAN

There has been a fundamental change in the relationship between drones and public safety, according to Charles Werner — and he would know. Having spent 45 years in the fire service, he retired as the fire chief for Charlottesville, Virginia, and went on to establish and lead DRONERESPONDERS, a global alliance of emergency-response agencies with more than 1,000 member organizations worldwide.

"Over the past couple of years, I've seen people come to a realization," said Werner. "Drones are more than just toys. Once people see what they can do, it quickly becomes part of the normal response in an emergency. Then, when it isn't available, people are asking, 'Where's the drone?'"

Charles Werner is the chief emeritus of the fire department in Charlottesville, Virginia, and the director of the DRONERESPONDERS network.

Along with this shift have come new approaches to how drones are deployed, and what sort of missions they are able to fulfill. As an example, Werner cites the development of multi-agency drone teams to better serve the entire community in the event of a major incident.

"In York County, Virginia, for example, there is a combined team that brings together people from both the fire service and law enforcement," he said.

The advantage of this approach is that whenever either one is facing a serious emergency—such as a big structure fire or an active-shooter incident—the affected agency wants all of its responders on the front line. During a three-alarm blaze, for example, the fire chief wants every firefighter on a hose line to bring it under control. However, the burden on law enforcement during the same incident is much less, meaning there will likely be a police officer available to fly the drone.

"Also, by using a multi-agency approach, all of the participants save money on training and equipment," Werner explained.

Another trend is for agencies to use new applications for drone technology once they start to gain operational experience with it.

"First, they are flying more missions than they originally anticipated," said Werner. "That means they need more pilots. Also, they start thinking about new missions for these aircraft, and now they realize they need one with a powerful zoom lens, or the option to deliver a payload, like a flotation device—and the small aircraft they started with doesn't have all those capabilities, so they start looking at larger platforms."

One trend that hasn't changed is for drone operations to be assigned to existing personnel as a collateral duty: that is, someone already employed by the agency as a firefighter or police officer will be trained to operate the drone—rather than hiring a qualified pilot from outside the organization.

GROWING FAST

DRONERESPONDERS launched in April 2019 and has been growing rapidly ever since: adding about 75 new members each week. One thing that has surprised Werner has been the growth in international membership.

"When we were looking to start the organization, we debated whether or not to aim for a worldwide

Drones provide firefighters and other first-responders with a quick and inexpensive solution to track events happening on the ground during emergencies, improving safety and providing for a faster, better-coordinated response.

audience, or just focus on the United States," he said. "We finally settled on focusing our efforts domestically (and) because the rules about drones are different between different countries, we didn't think we'd be able to keep up."

In spite of that fact, nearly 20 percent of the organization's membership is international, representing 55 countries around the globe.

"What has been really rewarding for me is that every time I check our website, we have 10 to 13 people online, and they are coming from everywhere: every state, but also South America, Puerto Rico, Ireland, London, Australia, New Zealand," Warner said. "People are coming from all over the world to utilize the resources that we have online."

In his view, one of the organization's biggest assets is its membership map, which allows first responders to identify other agencies in their local area that are using drones, opening up the possibility for learning, partnerships and mutual-aid agreements. The map is available for free on the organization's website (droneresponders.org).

"You can become a member through our website, too," said Werner. "It only takes about three minutes to get signed up."

Another benefit DRONERESPONDERS provides for its members, and the entire public safety community, is an annual survey that explores the use of drones by emergency response agencies.

"We're trying to find out what the state of public safety is: What are the trends that are happening out there. We also wanted to know things that would be of interest to our corporate patrons: What are their budgets? What new aircraft are they planning to buy?"

THE RESULTS ARE IN

About 600 agencies responded to the organization's 2021 survey. Before considering the results, it is important to recognize how this poll was conducted: DRONERESPONDERS sent the survey to each of its members, as well as non-member organizations through their profiles on social media platforms such as Facebook, Twitter, and LinkedIn.

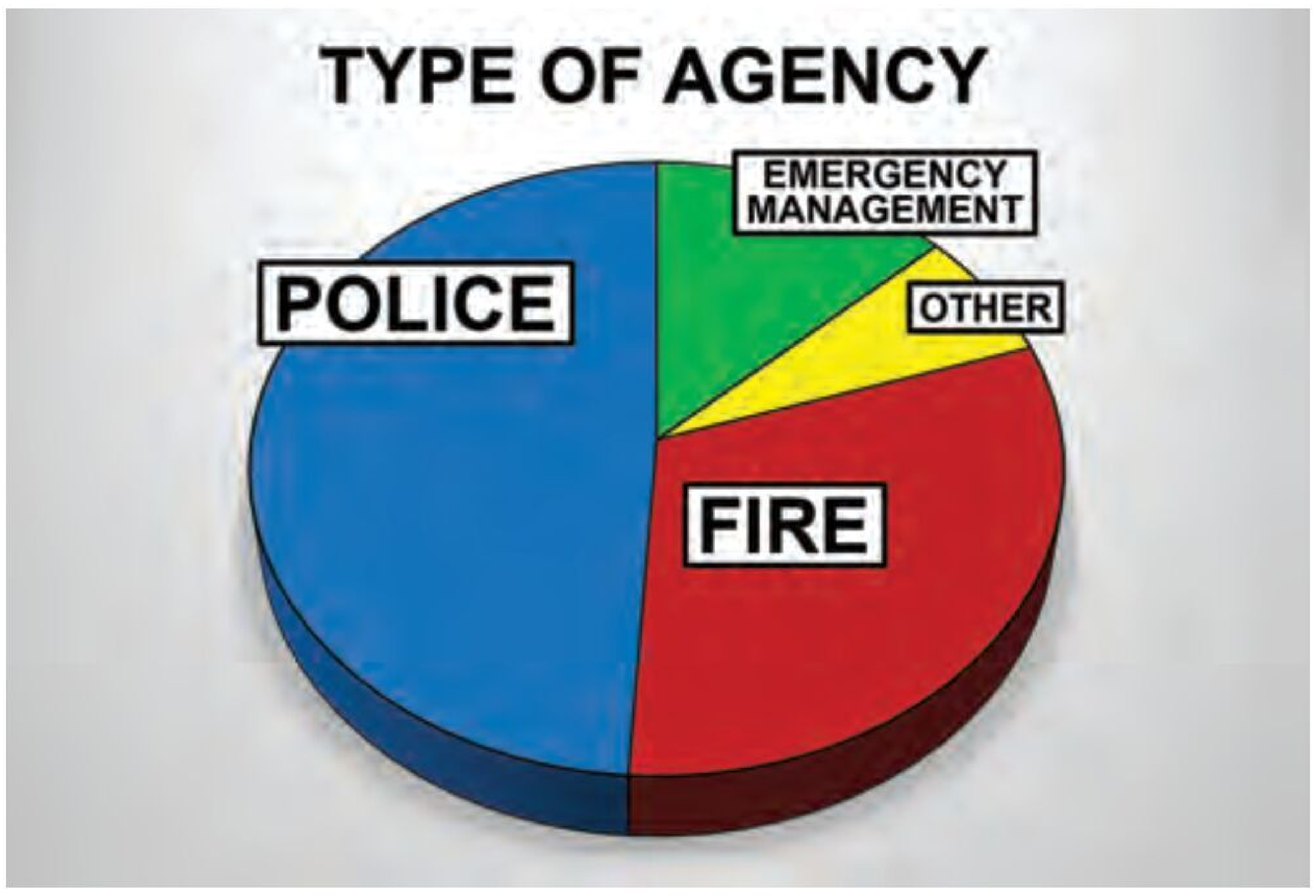
This is what social scientists refer to as a "convenience sample," which is data gathered from a group that was easy to contact but not necessarily representative of the overall population. If an agency is a member of DRONERESPONDERS, or follows the topic on social media, is it more likely to have a drone program or at least be considering whether to start one? You betcha!

Convenience sampling does not offer the same rigor or repeatability of a randomly selected sample of the population as a whole, but nevertheless it can provide some useful insights. For one, it appears that DJI continues to dominate its rivals in selling drones for public safety applications, with 90 percent of the respondents reporting they owned one or more aircraft from the Chinese manufacturer.

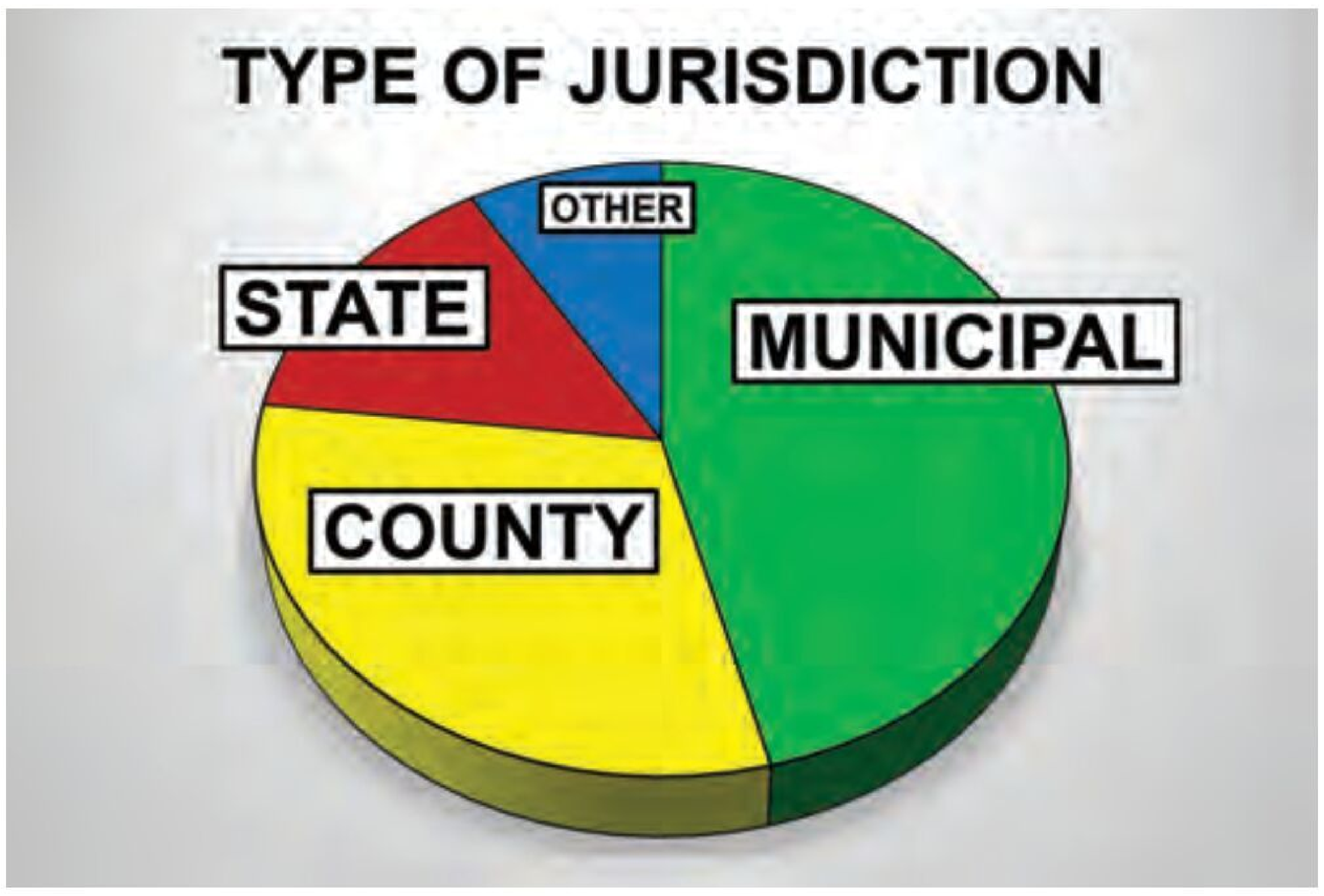
"We did see one interesting change from last year's survey," said Werner. "Last year, Skydio was the No. 2 manufacturer, but this year Autel Robotics took over that position."

Other key findings include the fact that of agencies with drone programs, less than half have been active for more than three years. Also, more than half of the agencies that responded to the survey have an annual budget for their drone program that is less than $10,000 per year—and grants and donations represent a critical source of funding for those programs.

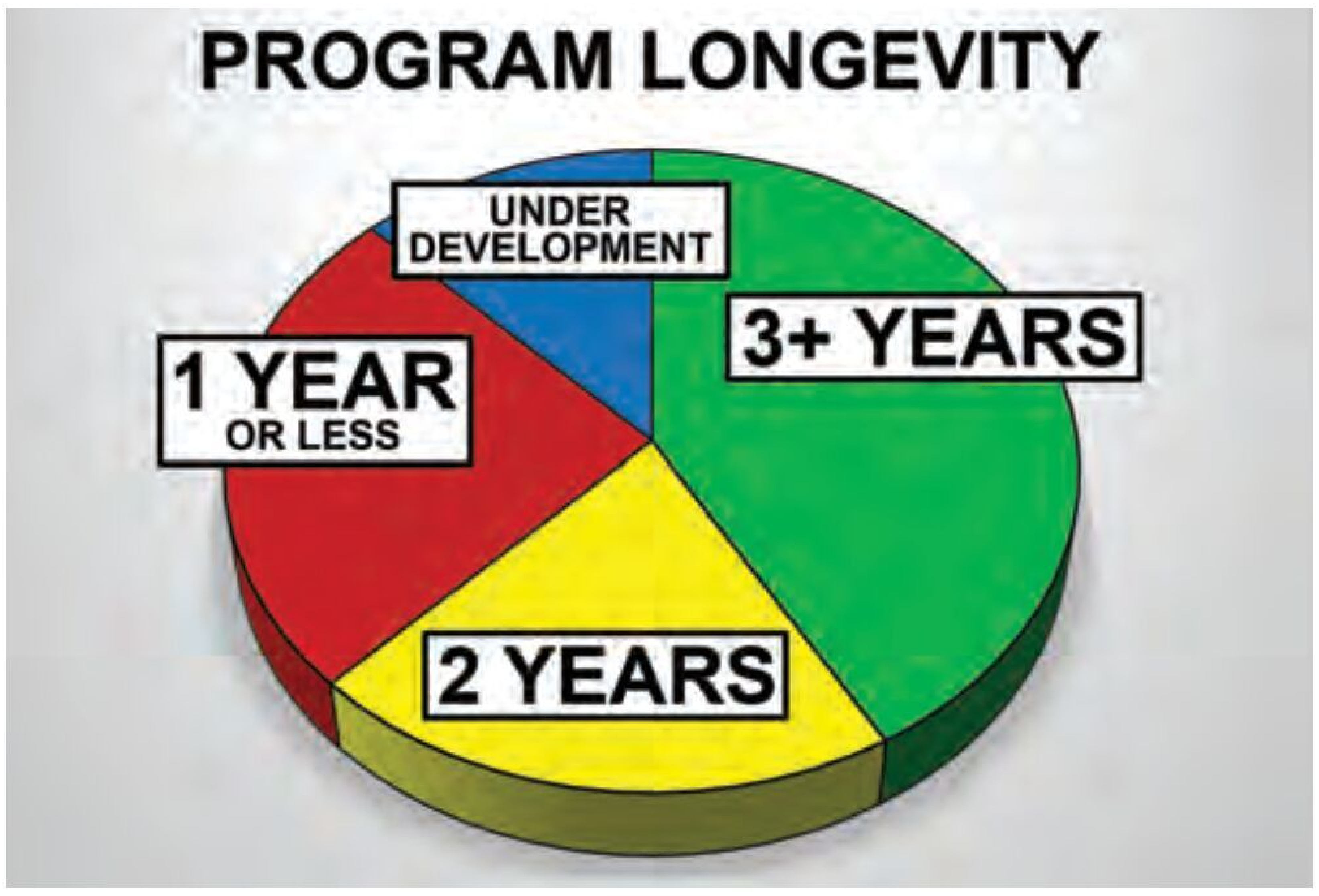
The majority of agencies have fewer than five pilots on staff and fly less than six missions a month, including training missions. About two-thirds of responses came from agencies that ranked the ability to fly beyond visual line of sight (BVLOS) as either extremely



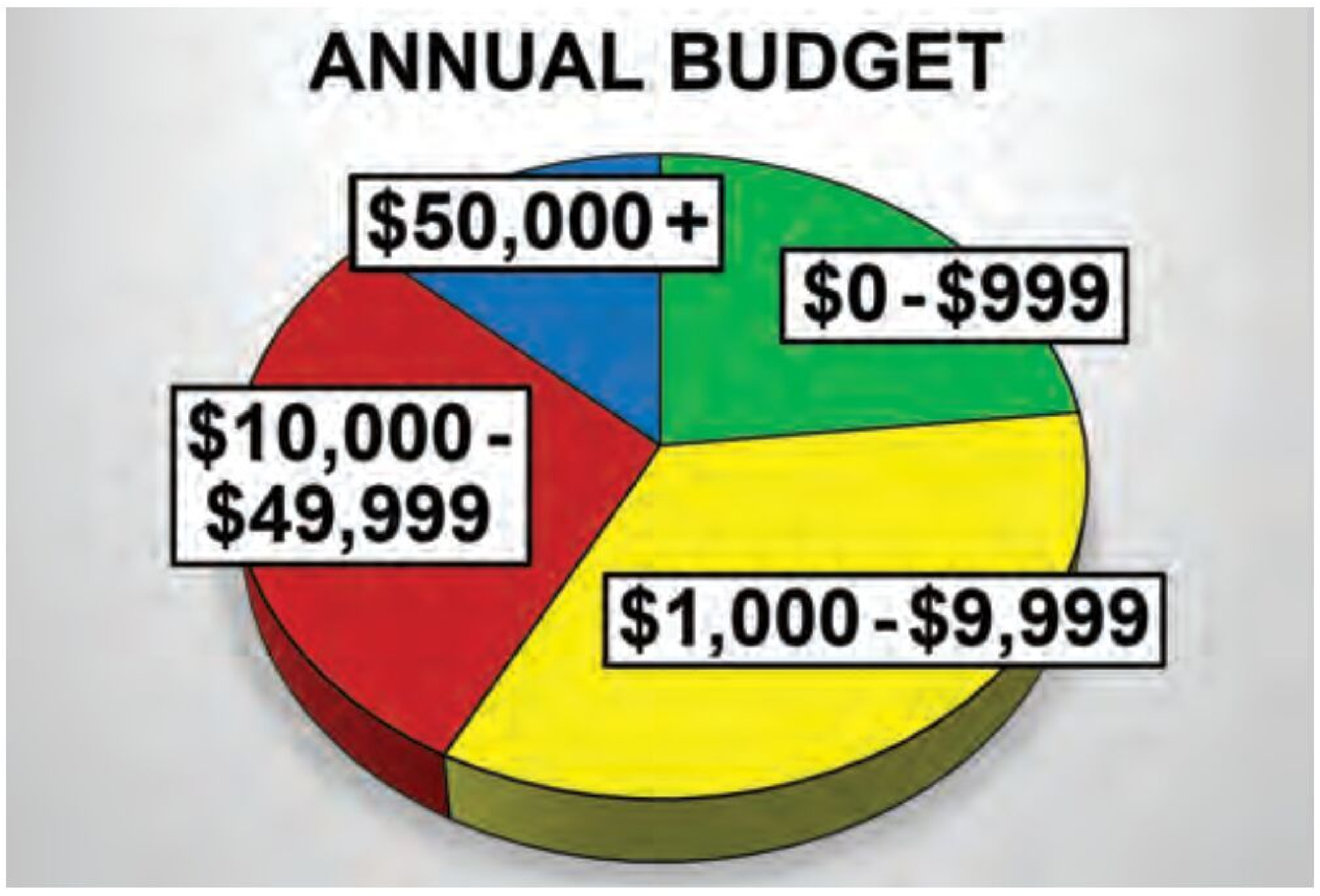
Nearly half of the agencies surveyed by DRONERESPONDERS in 2021 are law enforcement. Their ability to seize forfeited assets—cash and even drones—can be an important advantage when starting a new program.



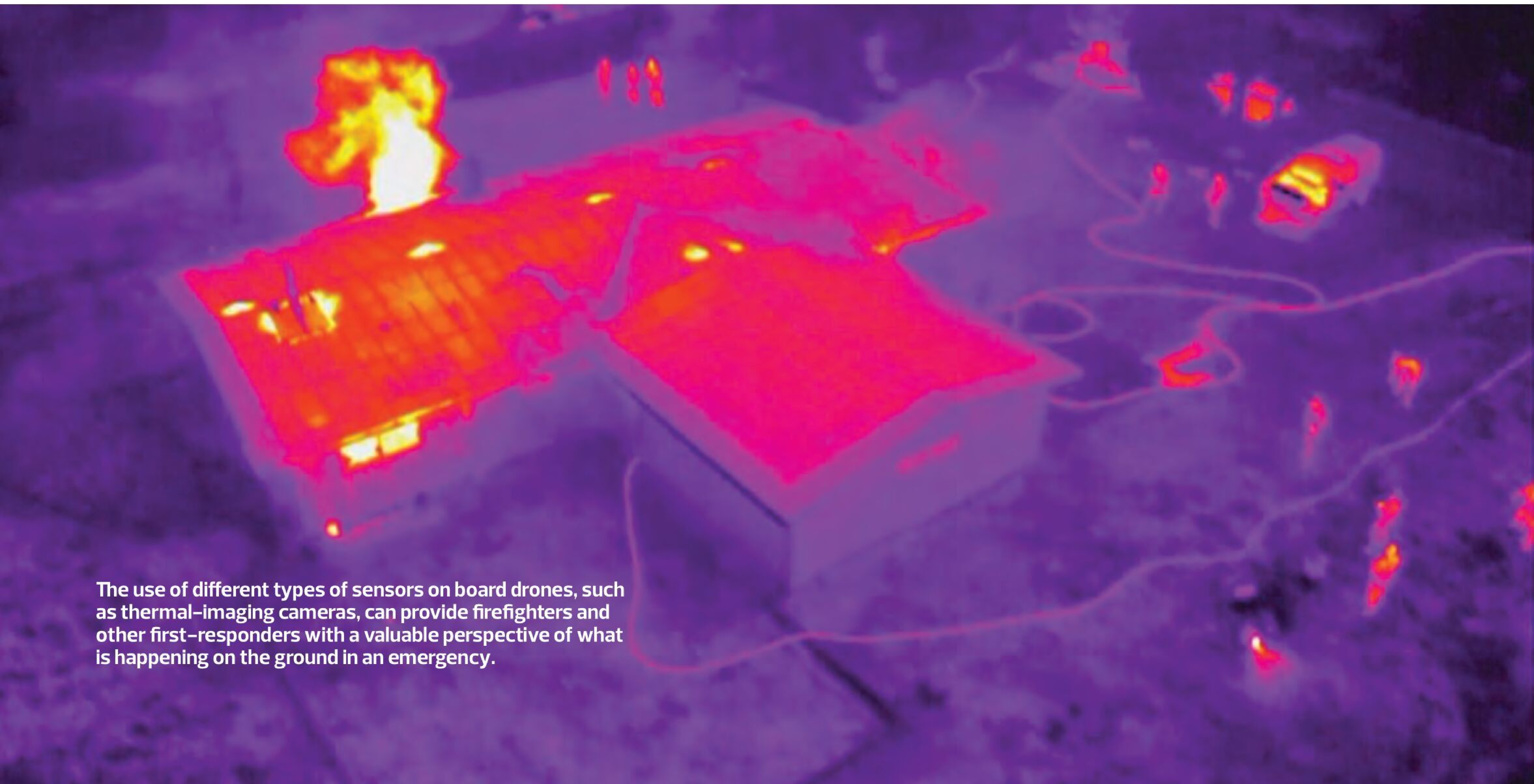
Of all the public safety agencies surveyed, the overwhelming majority belong to a local branch of government such as a county or city.



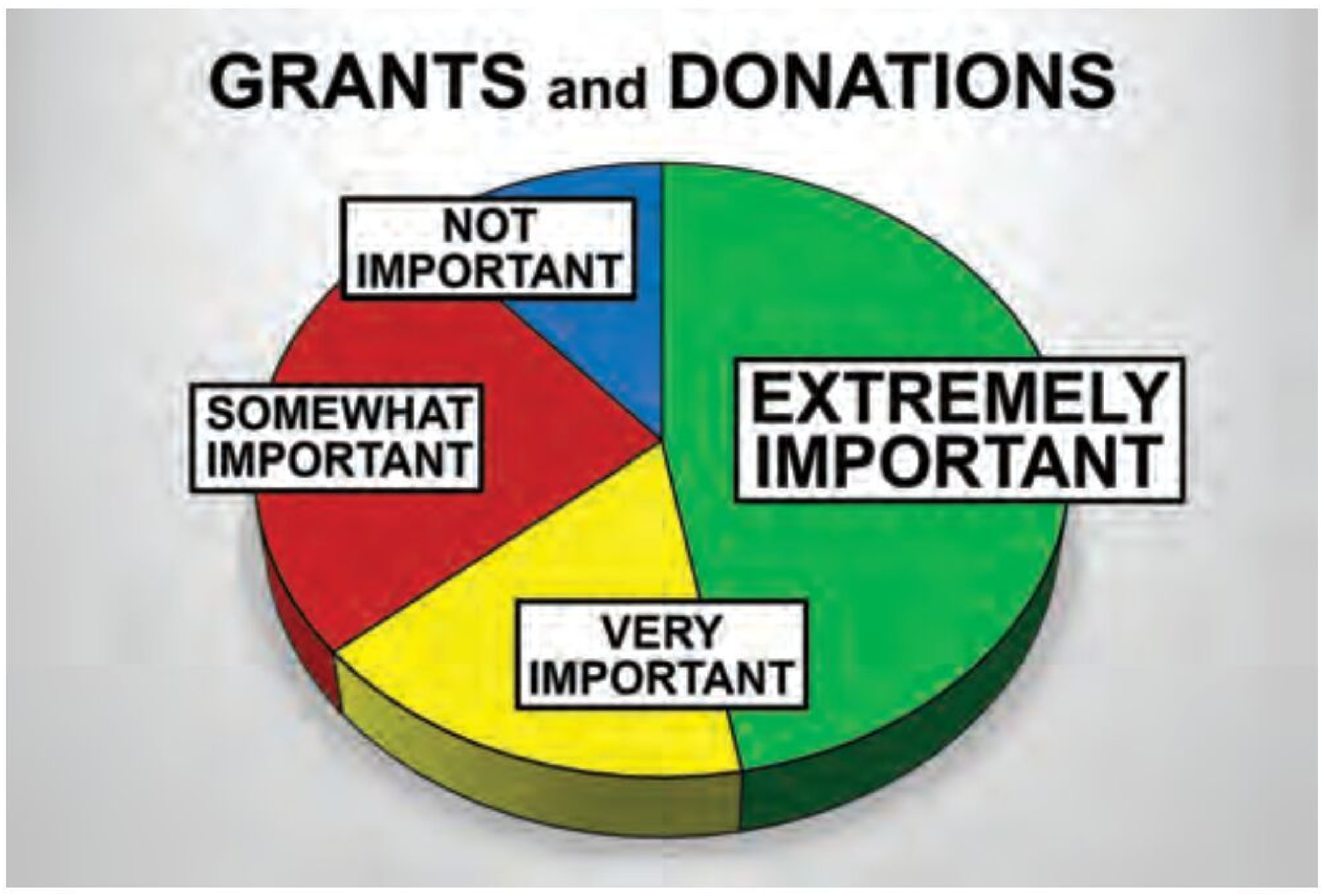
More than half of the public safety agencies that answered the DRONERESPONDERS poll have had a drone program for less than three years or are still considering developing one.



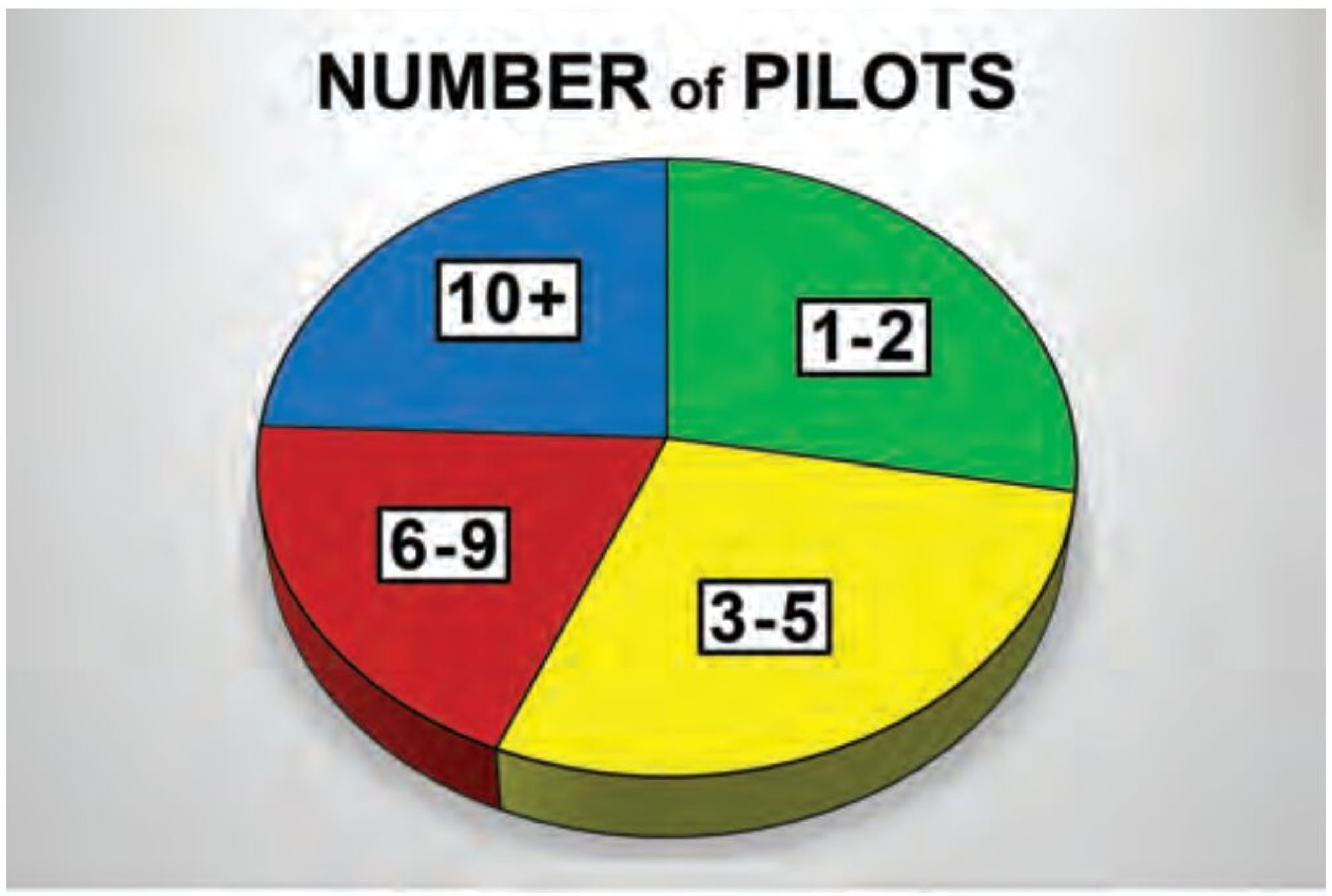
A majority of public safety agencies with a drone program have an annual budget of less than $10,000 to support their operations, including the acquisition of new aircraft, according to the DRONERESPONERS poll.



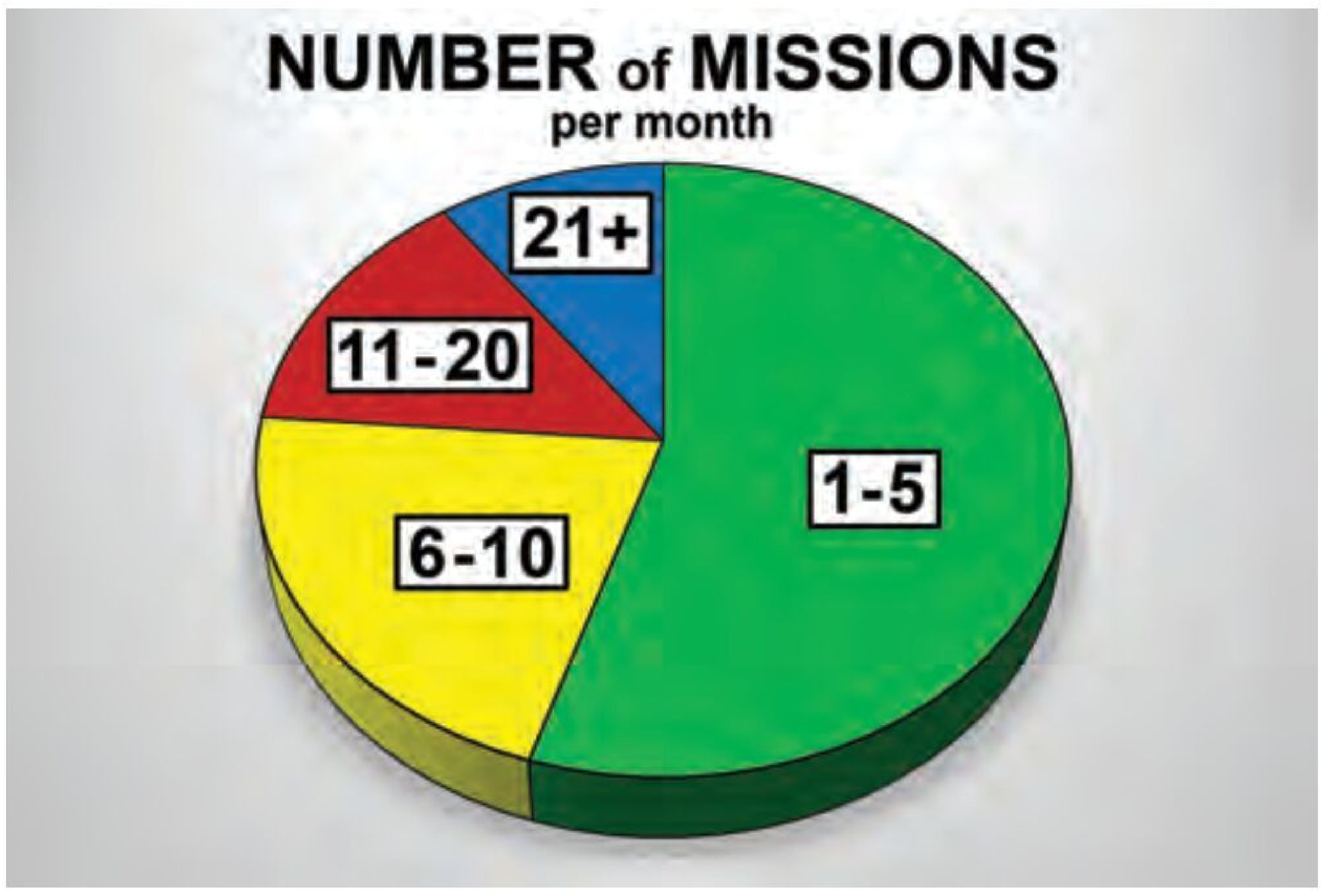
The use of different types of sensors on board drones, such as thermal-imaging cameras, can provide firefighters and other first-responders with a valuable perspective of what is happening on the ground in an emergency.



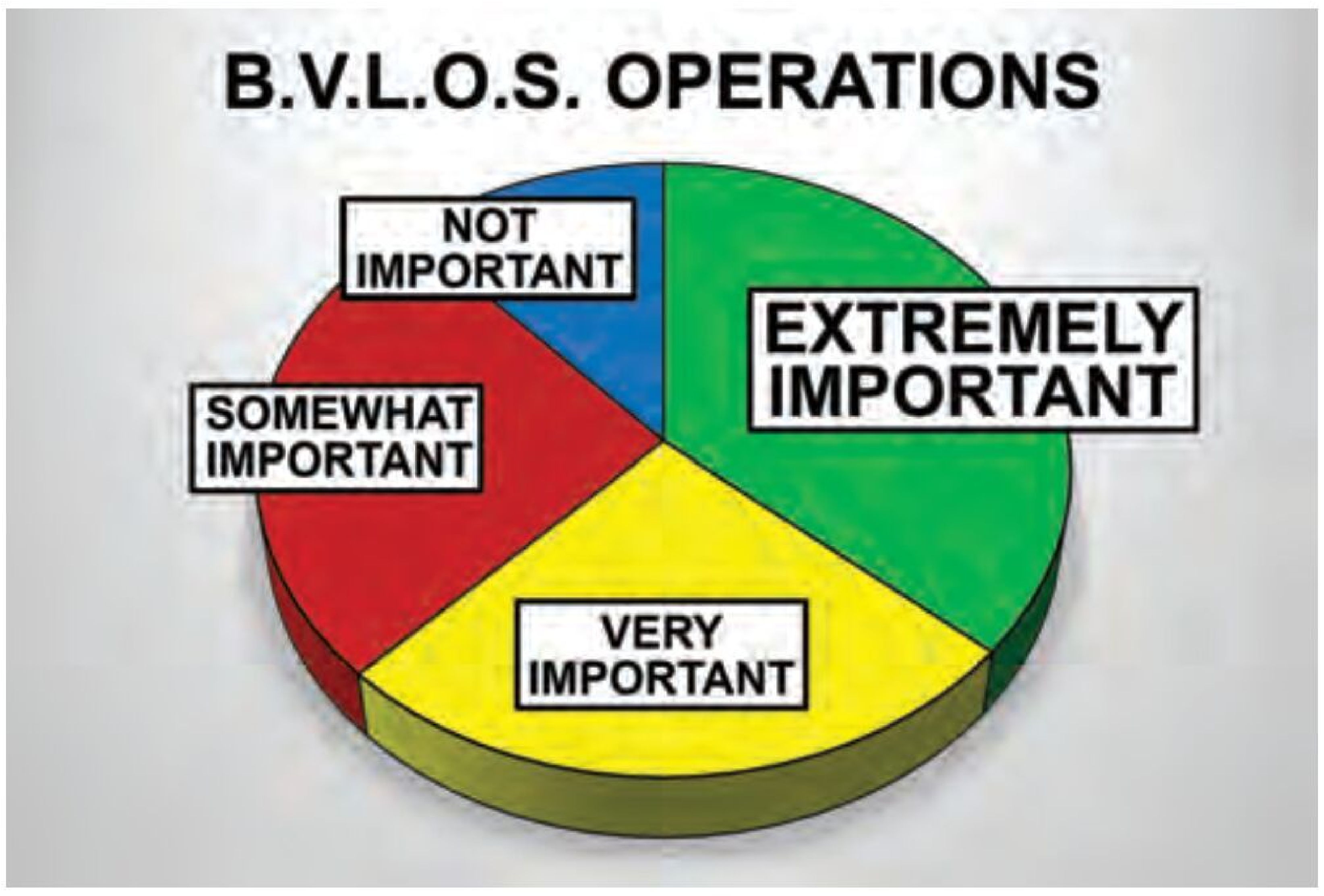
According to the DRONERESPONDERS survey, grants and donations are an essential source of funding for drone programs nationwide.



While it is still in the early days for drone programs across the public safety community, nearly a quarter of agencies that answered the DRONERESPONDERS survey indicated that they have 10 or more pilots in their organizations.



More than a half of agencies that provided feedback for the DRONERESPONDERS survey indicated that they fly between one and five missions per month, including training missions.



The results of the DRONERESPONDERS survey indicate a strong demand for the ability to operate drones beyond visual line of sight (BVLOS) to support public safety operations.

important or very important for their program to achieve its full potential.

THE FUTURE

In short, the use of drones in public safety is still in its early stages, but it is growing rapidly, and the leaders in this effort are beginning to make changes to the structure of their organization to take the maximum advantage of the possibilities offered by this new technology.

"We are beginning to see agencies where they are literally flying every day," said Werner. "For example, FDNY is going to full-time staffing for its drone units. Chula Vista, California, is also employing full-time pilots as part of their program."

He sees autonomous operations, drone swarms and BVLOS as being the next big steps forward for the use of drones by firefighters and police.

"Another part of that is going to be artificial intelligence to analyze the data coming from them," said Werner. "I'm working with NASA, and they are looking at doing something for disaster assessment—comparing satellite imagery from before the event with drone imagery gathered afterward. In our study, we saw 17 major use cases that were identified, and those are divided into three categories: pre-incident, during the incident and post-incident."

He also believes that the reliance on pilots with nimble thumbs to control the aircraft in real time is likely to wane as the technology continues to develop. "One thing I saw recently that made me think that is a company out of Israel called Highlander: you decide where you want the drone to do and you just push a button," Werner said. "Then, as the flight continues and its battery runs down, another drone is launched automatically to take its place before the first one returns to home, so you've got continuous coverage over an incident.

"You can still take direct control if you want to, but I think that will go the way of manual transmissions in cars: It's just easier to use an autonomous system except in a few, specialized applications."

Werner believes that in the next five to seven years, 90 percent of public safety agencies will have a drone program. He added, "I think that's the evolution that's happening—and it's happening pretty fast."

Drones and AI: SCE's Aerial Inspections

Drones are rapidly transforming industries like package delivery, agriculture, and even real estate. Electric utilities are no exception, and Southern California Edison is setting the pace among California's utilities. Its drone program is maximizing the technology with its more than 200,000 annual inspections of electrical infrastructure in high-fire-risk areas as part of its Wildlife Mitigation Plan.

Uncrewed aerial vehicles have become irreplaceable in performing inspections of the more than 400,000 poles, transformers and lines in SCE's high-fire-risk areas, or about 27% of its 50,000-square-mile service area. Aerial inspections in these areas are now done 75% by drones and 25% by helicopters, when just a year ago it was the exact opposite. Drones are also being deployed outside high-fire-risk areas for dam inspections, with programs planned for other SCE facilities.

"Drones and helicopters allow us to see our structures from a perspective that the ground inspectors cannot," said Alyssa Grigoryan, SCE principal manager of Aerial Inspections. "Looking at a structure from top down gives us visibility to issues and possible ignition risks that we may not see from the ground. Not doing aerial inspections is just not an option for us anymore."

Though SCE has conducted a Beyond Visual Line of Sight pilot, operators still only fly drones for inspections within their line of sight. A "next-level" new option for the bourgeoning program is the introduction this year of artificial intelligence (AI) and machine learning (Ml). Grigoryan's team is deploying the technology as an additional tool to help identify deterioration, often hard to see from the ground, on cross-arms and developing additional models for poles, transformers and other equipment.

With AI and MI, SCE drones' high-resolution photos of distribution and transmission infrastructure, attached equipment and their surrounding areas can be analyzed in a more efficient way. It all begins with computer models being trained to identify equipment requiring maintenance.

The technology eliminates some time-consuming routine tasks for SCE's inspectors—many of whom are former linemen and troublemen—allowing them to focus largely on ignition risks while also reducing inspection times.

"It increases efficiency, productivity and it increases our ability to identify issues in a much faster way, so it's very exciting," said Grigoryan. "This doesn't mean we're not going to need inspectors, it just means that the AI and MI models identify structures with deterioration right away so they can be inspected first.

Poloi Lin, a senior advisor on Grigoryan's team, said those structures requiring maintenance—numbering about 800 last year and nearly 500 so far this year and escalated as Priority 1 repairs—are fixed within 24 hours because of their potential fire risk.

Drone inspections of poles, power lines and other equipment now make up 75% of aerial inspections in high fire risk areas, up from 25% just last year.

Noting that at its peak, SCE's drone inspections are conducted by more than 100 two-person teams, Lin added that AI and MI helps immensely in the constant cycle of structure inspections that can exceed 10,000 weekly ahead of high fire season.

"[AI and MI] help our customers in that problems are avoided sooner and faster to keep the community safe," said Lin. "We can prevent outages and ignition risks and it is one additional tool that we can use to better maintain our system for our customers."

And Grigoryan said it is only the beginning for the advanced technology. While SCE is now mainly using AI and MI to pinpoint cross-arms requiring remediation, her team is partnering with other departments to build additional models for poles needing maintenance, faulty insulators and transformers while already piloting the immediate flagging of blurry photos for retaking and real-time streaming inspections.

"Basically, you'll have a pilot in the field manning the drone while at the same time an inspector in the office or from home inspects a structure in real time," said Grigoryan about streaming. "We can have the inspectors instruct the drone pilot to scoot over to the right, zoom in, scoot to the left and zoom out while performing an inspection in real time."

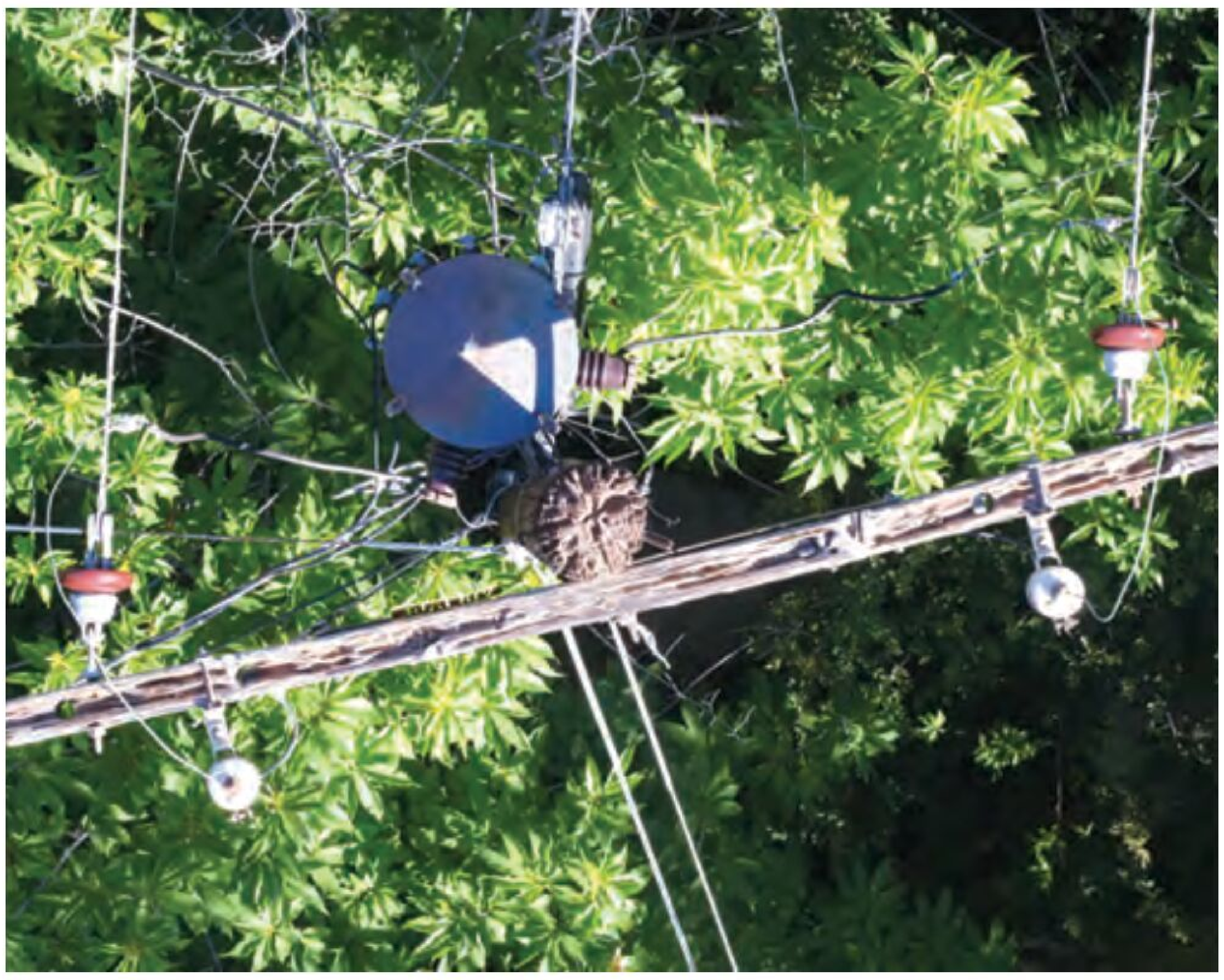
Taken from a drone, this photo reveals a cross-arm degraded by the environment and by woodpeckers, quickly recognizable by artificial intelligence that would not have been viewable from ground inspection.

She also said that streaming could possibly be used in pre- and post-Public Safety Power Shutoff (PSPS) power line inspections so power can be safely and quickly restored. Additionally, SCE is training its inspectors to eventually handle both ground and aerial inspections with a single visit, minimizing the inconvenience to customers of multiple visits and reducing program costs.

As for the drones, they are operated by FAA and SCE Air Operations-authorized pilots who follow SCE's stringent cybersecurity and confidentiality policies while flying mainly in residential and densely populated areas. Helicopters often fly in largely rural areas.

In addition to being quieter, drones can zoom in and capture crucial angles and details of components that helicopters can't, though helicopters can still capture their images faster.

It is technology that Grigoryan not only appreciates as a program lead but also as an SCE customer and resident of a high-fire-risk area herself, saying, "If Edison is in your neighborhood using drones and helicopters to do inspections, most likely that's because you live in a high fire risk area and we want to make sure we inspect all of the SCE structures in the neighborhood for your safety and the safety of the community."— By Paul Netter (Photos by Ernesto Sanchez & Roberto Lazarte)



WiBotic New Chargers and Transmitters

Developed for the Department of Defense, the new 300W OC-262 is a passively cooled onboard charger that will benefit operators in the oil and gas, mining, construction, marine exploration, and agriculture industries. The new OC-150 compact and lightweight onboard charger delivers 150 watts of power and up to 10A of current, depending on battery voltage.

A compact transmitter, the TR-150 uses the latest high-efficiency GaN transistors and is designed primarily for use with the new OC-150 onboard charger. Th new TR-300 is a compact wireless power transmitter using GaN Systems' technology for maximum efficiency.

"When it comes to power delivery for autonomous drones and mobile robots, it's crucial to innovate with new technologies such as GaN to maximize efficiency," said Ben Waters, CEO at WiBotic. "These new products not only push that technical envelope but are also designed to survive in the most extreme operational conditions. And when used together with WiBotic software, they now let operators track and optimize the performance of individual batteries within large and diverse collections – whether charging is performed manually or fully autonomously."

wibotic.com

A2Z Drone Delivery RDSX

This new commercial delivery drone uniquely addresses the most-pressing consumer safety and privacy concerns hampering residential drone delivery. The new A2Z Drone Delivery RDSX is a human-centered design that helps put package recipients at ease with the burgeoning residential drone delivery technology.

This dual-payload commercial delivery UAV combines A2Z Drone Delivery's proprietary tethered freefall delivery mechanism with a proven airframe enabling drone delivery at scale by streamlining multi-destination flights, minimizing delivery time-on-station and mitigating many of the consumer concerns with residential drone deliveries. A2Z's tethered freefall mechanism has previously been deployed for residential drone delivery trials.

Consumers obviously have several concerns about the expansion of drone delivery including the potential for injury and property damage from spinning drone rotors as well as erosion of personal privacy. A2Z's unique tethered freefall delivery method helps mitigate these concerns by depositing payloads from altitude (usually about 150 feet). This keeps spinning rotors away from people and property, helps mitigate detrimental rotor noise, and eliminates concerns with low-flying drones peeking in windows. It also enables pilots to deliver to locations where a drone can't land, like dense woods or around powerlines.

atozdelivery.com

FIXAR BlackBox

Effective September 2021, FIXAR will equip all of its outdoor drones with their BlackBox system for UAV flight data logging to increase traceability and accountability of the aircraft and contribute to safer air traffic.

The lightweight FIXAR BlackBox is a separate module that records complete and detailed information of onboard flight activities and parameters. This advanced logging system can record and store settings, missions, sensor data, user commands, automatic control, and payload information.

The main objective of the BlackBox is to increase safety by providing detailed data for mission analysis, identify faults in case of incidents, and contribute to a more efficient monitoring and problem-solving and overall UAV industry security and development.

Apart from the main objective to offer additional safety and flight data storage tasks, the BlackBox is a valuable and practical back-up system for the collected data by the payload, including laser scanners and cameras. The metadata of the mission can be exported using LogExport software without data loss.

fixar.pro

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Advanced Aircraft Company "HAMR"

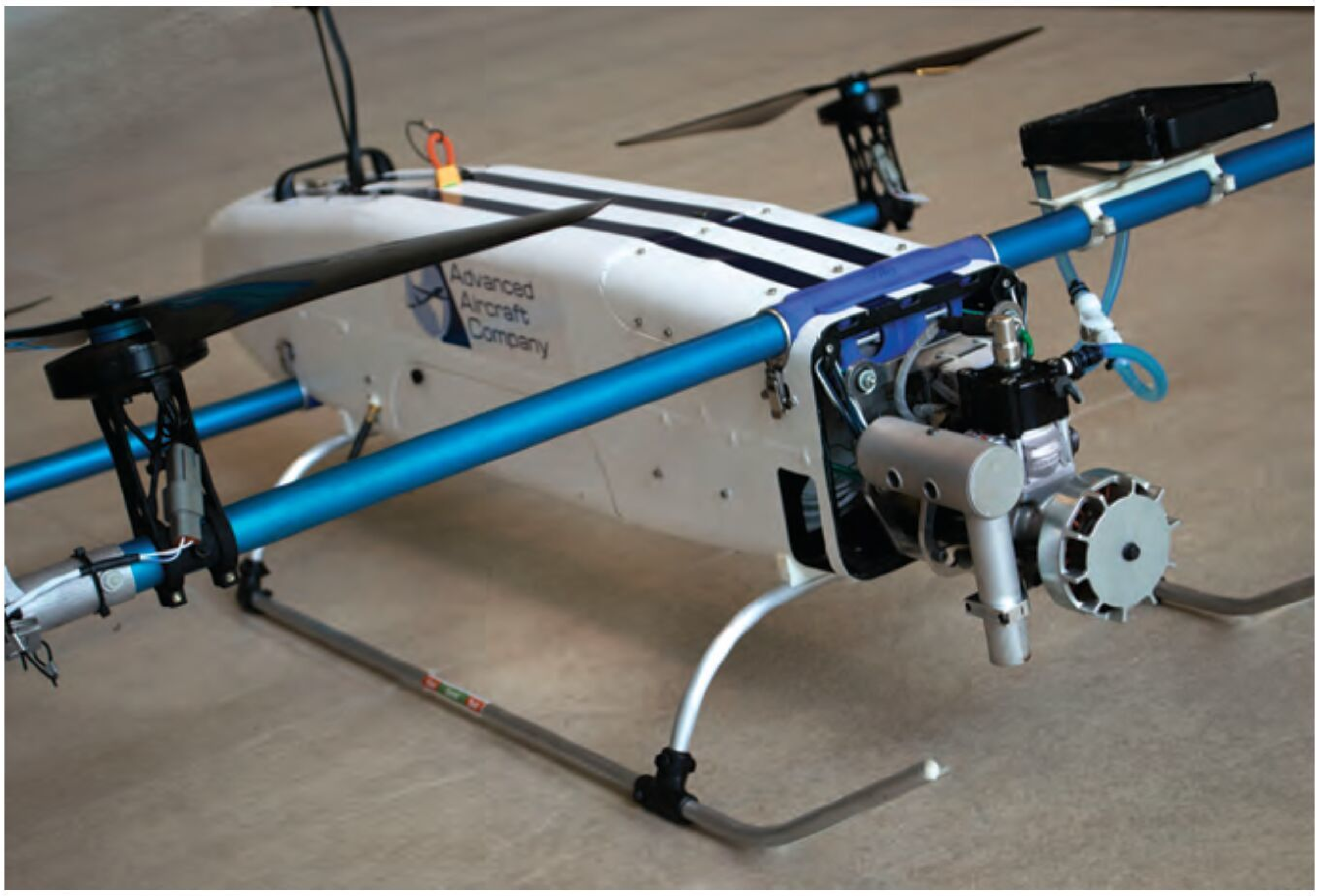
Advanced Aircraft Company (AAC), a developer of long-endurance hybrid-electric unmanned aircraft systems, launched of its Hybrid Advanced Multirotor Unmanned Aircraft System (HAMR), a versatile multi-rotor configuration with a hybrid gas-electric propulsion system for extended endurance and multiple, simultaneous payload capabilities.

"After four years of development, testing, and validation, we are proud to announce our entry into the unmanned systems market with HAMR," said Bill Fredericks, founder and CEO of AAC. "Our high-performance gas-electric hybrid propulsion system And aerodynamic airframe designs enable long-endurance operations. This provides a significant competitive advantage to our customers by doubling the productivity of their pilots."

The HAMR has been optimized for a wide range of commercial, defense and public safety applications, including surveying and mapping, critical infrastructure inspection, precision agriculture, public safety and defense applications, and search and rescue missions.

The HAMR has a hybrid gas-electric propulsion system with an electronic fuel injected and computer-controlled 35cc single-piston engine driving an integrated generator producing up to 2000W to power six independent brushless DC electric motors and a backup battery. This configuration allows for up to 3.5 hours of flight time—six times longer than a conventional battery-powered multirotor aircraft. Multiple redundant systems, remote engine starting, and onboard batteries ensure the aircraft can operate with a high margin of safety. In the event of an engine failure or an electric motor failure, the craft can abort and land safely.

flyaac.com



GE Microdrones

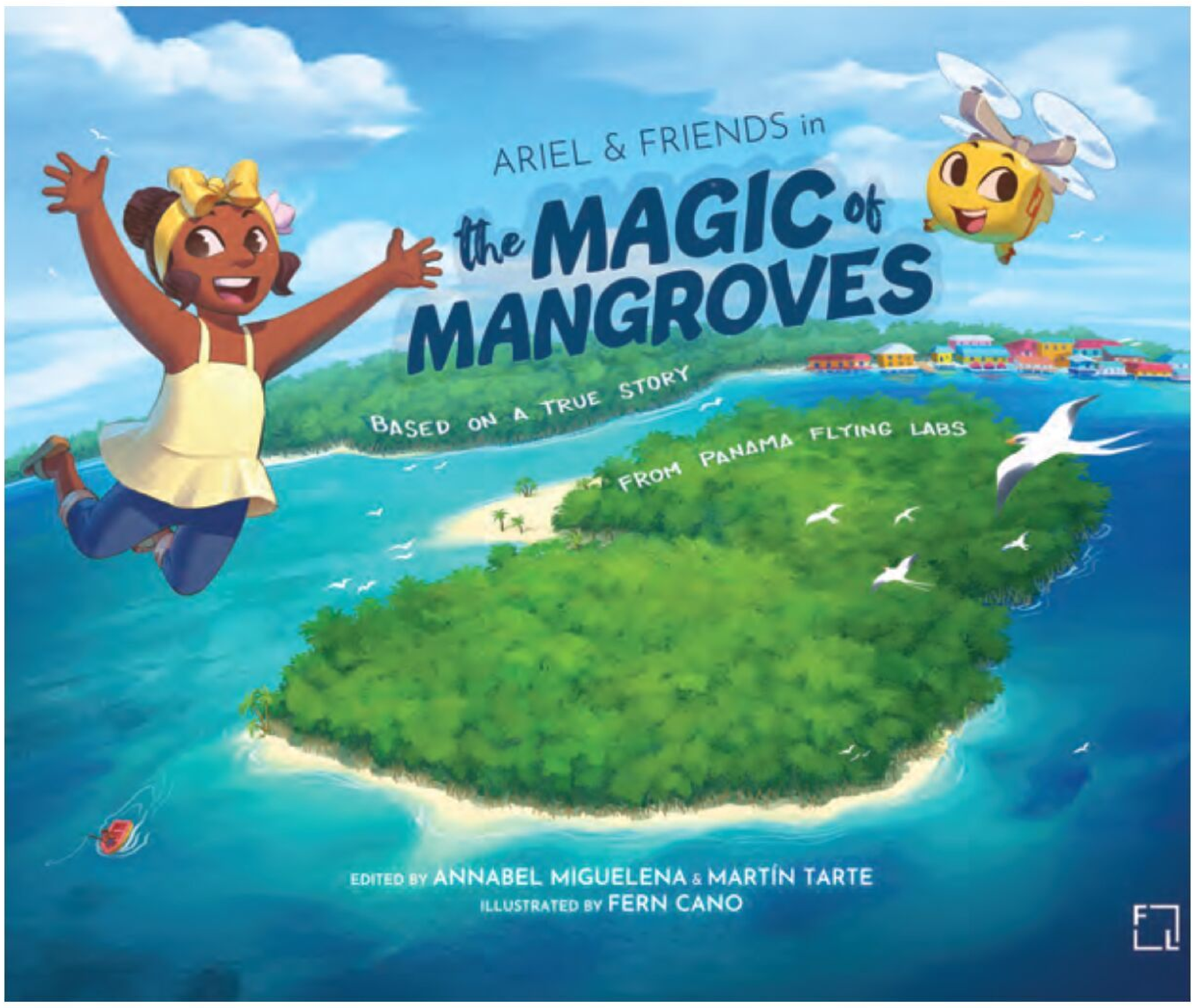
The new GE industrial drone line is based on the md4-1000 platform from Microdrones and includes a 10% increase in motor efficiency as well as LED light rings to provide enhanced visibility with configurable color schemes. The systems are also Remote ID Enabled for increased safety and compliance and include a new ground collision avoidance feature.

The all-new mdLiDAR1000LR (long-range) UAV features a Velodyne Ultra Puck VLP-32 LiDAR scanner in the payload and a 26-megapixel CMOS APS-C camera sensor for photogrammetry. The mdLiDAR1000HR (high-resolution) has a Velodyne Puck VLP-16, a Sony IMX264 LiDAR scanner, and a 5-megapixel camera integrated for point-cloud colorization. The mdMapper1000DG features a payload with the Sony RX1R II and a 42-megapixel full-frame camera integrated. All of these aircraft are equipped with the Applanix 15 UAV IMU for direct georeferencing. The mdMapper1000DG 3D has a new array of five cameras all integrated into one oblique sensor system, with five Sony 24-megapixel APC-C sensors. It also has the Applanix APX-15 UAV system, which is PPK and DG enabled. The final system in the GE industrial drone line is the mdTector1000CH4, which is used for inspecting methane gas infrastructure. The mdTector1000CH4 includes a Pergam Laser Methane Falcon sensor for detecting gas at a hundred meters AGL in real time.

In addition to the sheer capability of the drones, a key component of the GE industrial drone line from Microdrones is the easy-to-follow workflow of "plan, fly, and process and visualize." These are not standalone drones—Microdrones provide the hardware, software, workflows and training to get the most out of the drones as a surveying tool.

microdrones.com

Flying Labs/ WeRobotics Drone Picture Books



From birds, to kites and airplanes, kids have always marveled at all that flies. They'll also marvel at Ariel, a small but sturdy flying robot who connects her flying friends with diverse local communities to solve real-world problems. Creatively designed for young minds between the ages of 2 to 8, Ariel & Friends is a series of children's books that takes its readers all over the globe using Flying Labs projects to show them how local experts are solving problems using science, teamwork, and some really fancy robots. The series will feature stories from Latin America, Africa, and Asia. The first book in the series, "The Magic in the Mangroves," is based on a real project led by Panama Flying Labs. For more information, check out the Flying Labs project on Kickstarter.

ANRA Technologies Airspace Management Tests

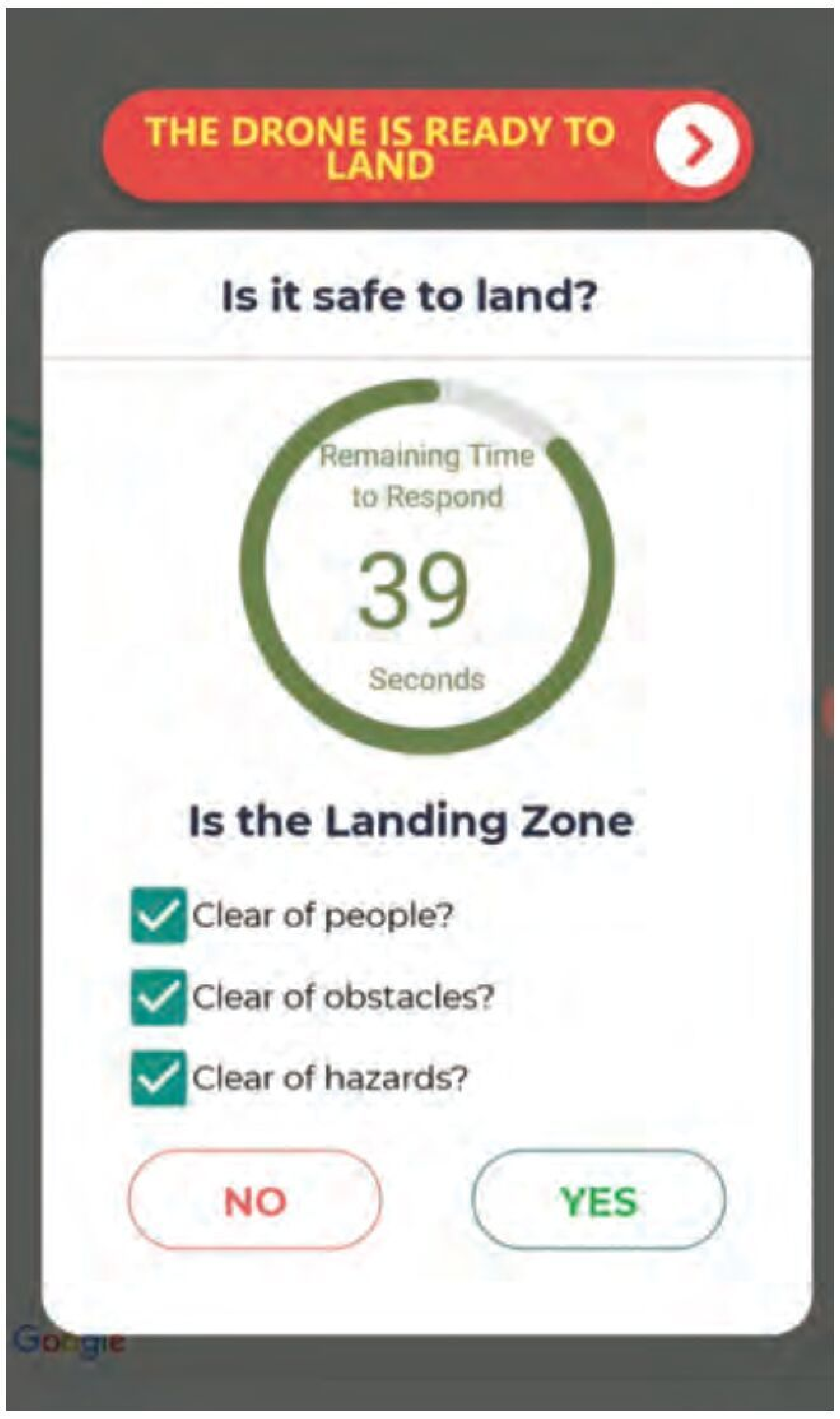
ANRA Technologies successfully flew a series of drone delivery demonstrations at Florida Department of Transportation and Florida's Turnpike Enterprise SunTrax facility. ANRA flew its VTOL drone that can carry a 3-pound payload over long distances with a flight time of more than 90 minutes. The drone was connected to ANRA's delivery and airspace management software to demonstrate its entire ecosystem comprised of a drone, delivery/order app, and airspace management platform.

ANRA's delivery software provides a network that enables drone deliveries by managing orders, inventory, and provisioning products—then safely operates the drone within the UTM network. ANRA's delivery software incorporates airspace management technology to enable safe flight routing for the drone while providing tracking and status updates to the customer on a mobile app. The solution provides vital information and data exchanges for compliant and efficient delivery operations.

ANRA's delivery platform demonstrated how a First Responder can order an EpiPen from the State Emergency Response Team for drone delivery over inaccessible roads that were flooded by a hurricane. This scenario was flown several times during the event for attendees, with the delivery/order app flow and airspace management details projected onto a large screen while the drone flew the live mission, allowing the attendees to view the entire process and workflow.

ANRA is the only known company that offers the option to insert your own drone hardware into a delivery network that includes technology to help develop a safety case for BVLOS operations. All stakeholders in the supply chain have appropriate levels of access and credentials to view, control, and manage their respective tasks along the network and to have complete situational awareness on inventory, package health status, and order progress.

anratechnologies.com



THE DRONE IS READY TO LAND

Is it safe to land?

Remaining Time to Respond

39

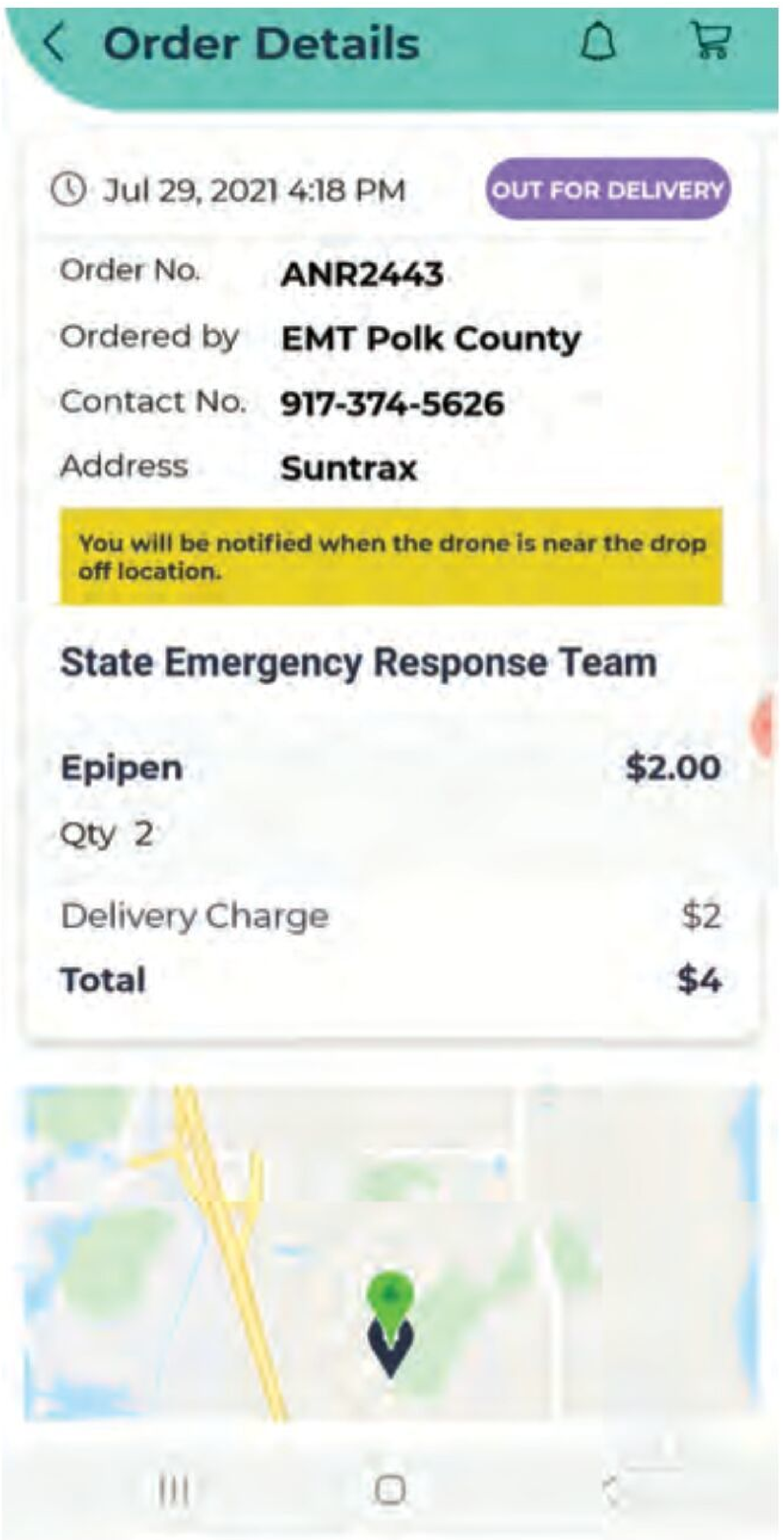
Seconds

Is the Landing Zone

☑ Clear of people?

☑ Clear of obstacles?

☑ Clear of hazards?



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Jul 29, 2021 4:18 PM

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State Emergency Response Team

Epipen	$2.00
Qty 2	
Delivery Charge	$2
Total	$4

SwellPro SplashDrone 4

This fifth-generation waterproof drone is designed for multipurpose operations in any harsh environments, and its new IP66 Waterproof Remote Controller and 2-inch digital telemetry display is waterproof, too! The drone's built-in GPS now offers real-time tracking and dynamic return to pilot. Also new is SwellPro's GC3-S, a fully waterproof, 4K camera stabilized by a 3-axis gimbal, and "boat kit" floats that allow SplashDrone 4 to sail on the water while taking underwater shots. The SplashDrone 4 starts at $1,799.99; the GC3-S is $699 and the boat kit is $99.

swellpro.com

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Skateboarding Drones

Drones are new to skateboarding, and they offer an entirely different aesthetic to the sport. "Mirador" was one of the first skate videos to properly make use of the drone. And as the second installment of the project, "Mirador 2," comes out, I asked drone pilot David Lougedo about the pros and cons of using this new technology to capture skateboarding.

"My favorite shots were the closeups of skater Marek Zaprazny where we were able to pull back after and show off the spot." The drone is able to hover above the skater after the trick is done and show the spot and its surroundings.

"It's definitely hard to film with the drone," says skater Kevin Baekkel. "Sometimes the drone hits you and crashes." It is this problem that led pilot David to 3D print his own add-ons for the drone.

"The GoPro is mounted with a 3D printed piece that holds the GoPro with its two-leg system," he says. The blue guards that protect the rotors are also 3D printed and are important when filming a sport that involves a lot of crashing into walls and pavement.

It is perhaps the modular nature of drones which make them so well adapted for skateboarding. They fit the DIY aesthetic of the sport. Baekkel said, "To reduce the weight of the GoPro, I had to remove the battery and feed the GoPro from a 5V USB-C connector I built into the drone myself."

One challenging aspect of filming with the drone is the noise. "The sound always has to be recorded before we fly the drone. Normally we ask the skater to do a similar line but with easier tricks to simulate the sound. The drones are too loud for us to use the original audio," says Mirador videographer Marco Savino.

David's main concern was powering his fleet of drones. "I brought 10 batteries for the drone with the disassembled GoPro.15 for the drone that carries the regular GoPro. And six for the long-range drone that flew in the mountains and along the coast." David added, "I travelled with three chargers. The small chargers are so compact that I bring them with me in the van. At night, I charge the other batteries, ready for the next day."

In the first installment of Mirador, a drone was flown through the legs of a skateboarder as he was doing a particularly difficult balancing maneuver. This begs the question: will we reach a point when the technical prowess of the pilot outshines the skills of the athlete being recorded?—By Daryl Mersom (Photos by Marco Savino & David Lougedo)

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» Litter cleanup
» Pest control
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1 "Medicare & You," Centers for Medicare & Medicaid Services, 2021. 2 "How might my oral and dental health change as I age?", www. usnews.com, 11/30/2018. 3 American Dental Association, Health Policy Institute, 2018 Survey of Dental Fees, Copyright 2018, American Dental Association.

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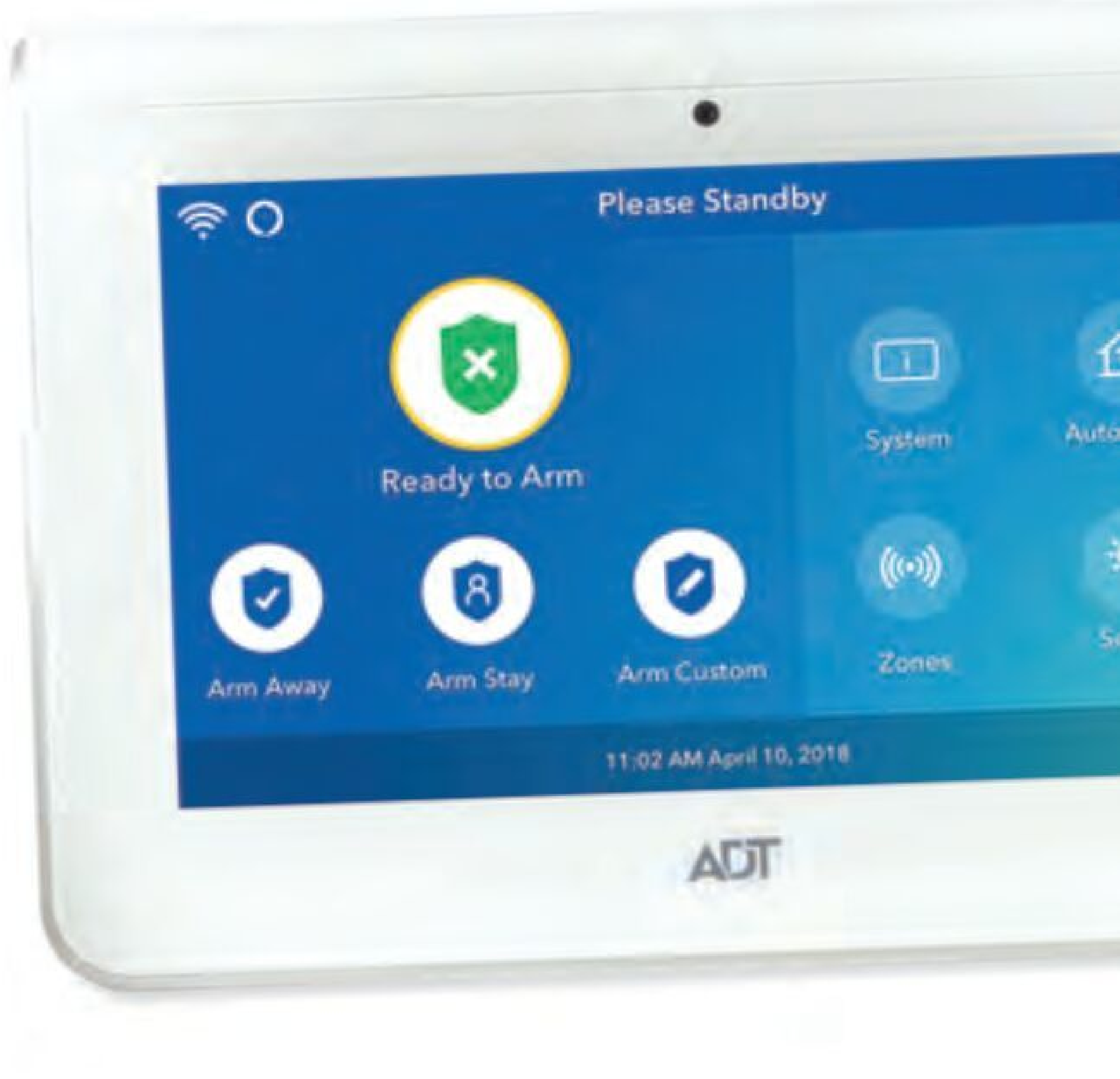

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FIVE BEST BUYS

From fun flying cameras to serious work rigs

By Team *RotorDrone Pro*

This guide highlights five of our top-rated drone picks. Whether you're in the market for a drone to take on vacation or you're a commercial pilot looking to upgrade your system, we've got the lowdown on what you want to know, including Quick Specs and Features lists for easy comparisons. From basic enthusiast drones to serious machines with all the bells and whistles, you're sure to find what you need here.

DJI MINI 2

MINI 2
ULTRA LIGHT 249g

This feature-packed drone comes in an ultra-compact package, making it the ideal traveling companion for anyone who'd like to document their adventures. It is incredibly stable and easy to fly, but it does not have obstacle avoidance or object tracking. It has stronger motors than its predecessor and can easily handle a light breeze (but if it's windy, the Mini 2 should stay grounded).

The Mini 2 comes with a redesigned controller that looks like the one that comes with the Mavic Air 2. It holds your smartphone and is comfortable and easy to use. OcuSync, DJI's low-latency radio frequency that allows you to transmit 1080p 720p video from the Mini 2 directly to your smart device. To fly the Mini 2, you use DJI's Fly app, a basic version of DJI's Fly 4+ app. It comes with one Intelligent battery that can be charged using the included USB cable.

The included 1/2.3-inch, 12MP camera takes great photos that you can adjust in the DJI app.it can shoot 4K video at 100 Mbps bit rate up to 30 fps, and daylight video looks sharp and not overly processed. The Mini 2 has 2x zoom, but images and video quickly become pixelated. A bonus is that the Mini 2 supports DJI's smart panorama modes, like 180-degree view, wide-angle, and sphere. For videos, DJI's Trimmed Download mode lets you separate clips before you download them to your smartphone for editing, which saves time and

phone memory.

Keep in mind that unlike its larger siblings in the DJI lineup, the Mini 2 does not have obstacle avoidance or object tracking, but it does have automated shot modes. Downward-facing sensors allow it to avoid the ground and land on its own.

The Mini 2 is a highly portable drone that's ideal for enthusiasts who want to capture their adventures. Because of its light weight, it does not need to be registered with the FAA.

QUICK SPECS

Model: Mini 2

Manufacturer: DJI (dji.com)

Size: 245 x 280 x 56 mm (unfolded)

Weight: 249g

Sensor: 1/2.3 CMOS

Images: 4K video; 12MP still

Prices: $440; $600 (Fly More Combo w/extra batteries and carrying case)

FEATURES

- Lightweight and folds down for very easy transport
- Clear 4K video and ability to shoot 12MP stills
- Flight times of up to 30 minutes
- Incredibly stable and fun to fly

Photos by Margirita Puma

SKYDIO 2

The Skydio 2 has six 4K cameras, each with a 200-degree field of view. Together, they create a complete picture of the operating environment in every direction, generating 45 megabytes of data 30 times per second to drive its remarkable collision avoidance system. Its main camera—the one that actually captures video and still images—incorporates a Sony IMX577, capable of shooting 4K video at 30 frames per second (FPS) or HD video at up to 120 FPS in addition to 12 megapixel stills. The images are vibrant, and even without activating the camera's high dynamic range (HDR) capability, it does a remarkable job of balancing the lighting across a scene. The camera has three-axis stabilization and is slung on a front-mounted gimbal so that no part of the aircraft hangs over it. Note that the camera stops at 45 degrees above the horizon, limiting its use inspecting the underside of a bridge deck, for example.

The airframe feels very sturdy, no doubt because of the magnesium skeleton beneath its distinctive blue and black plastic skin. Because of its rigidity—a must for its collision avoidance system—the Skydio 2 does not fold down for travel or storage.

Power is supplied by a rechargeable, three-cell, 4280mAH LiPo battery which in real-world testing delivered about 15 minutes of flight time.

For takeoff, you just need to place the Skydio 2 on a clear patch of ground and push a button while it does its thing without any input from you. It also lands autonomously. The Skydio 2 incorporates groundbreaking technology to achieve an extraordinary degree of autonomous capability—actively tracking a subject through an environment crowded with obstacles while completing maneuvers that would overwhelm human pilots.

The Skydio 2 is ideal for aerial photography and videography enthusiasts.

QUICK SPECS

Name: Skydio 2

Manufacturer: Skydio (skydio.com)

Size: 223 x 273mm

Weight: 775g

Flight time: 15 min.

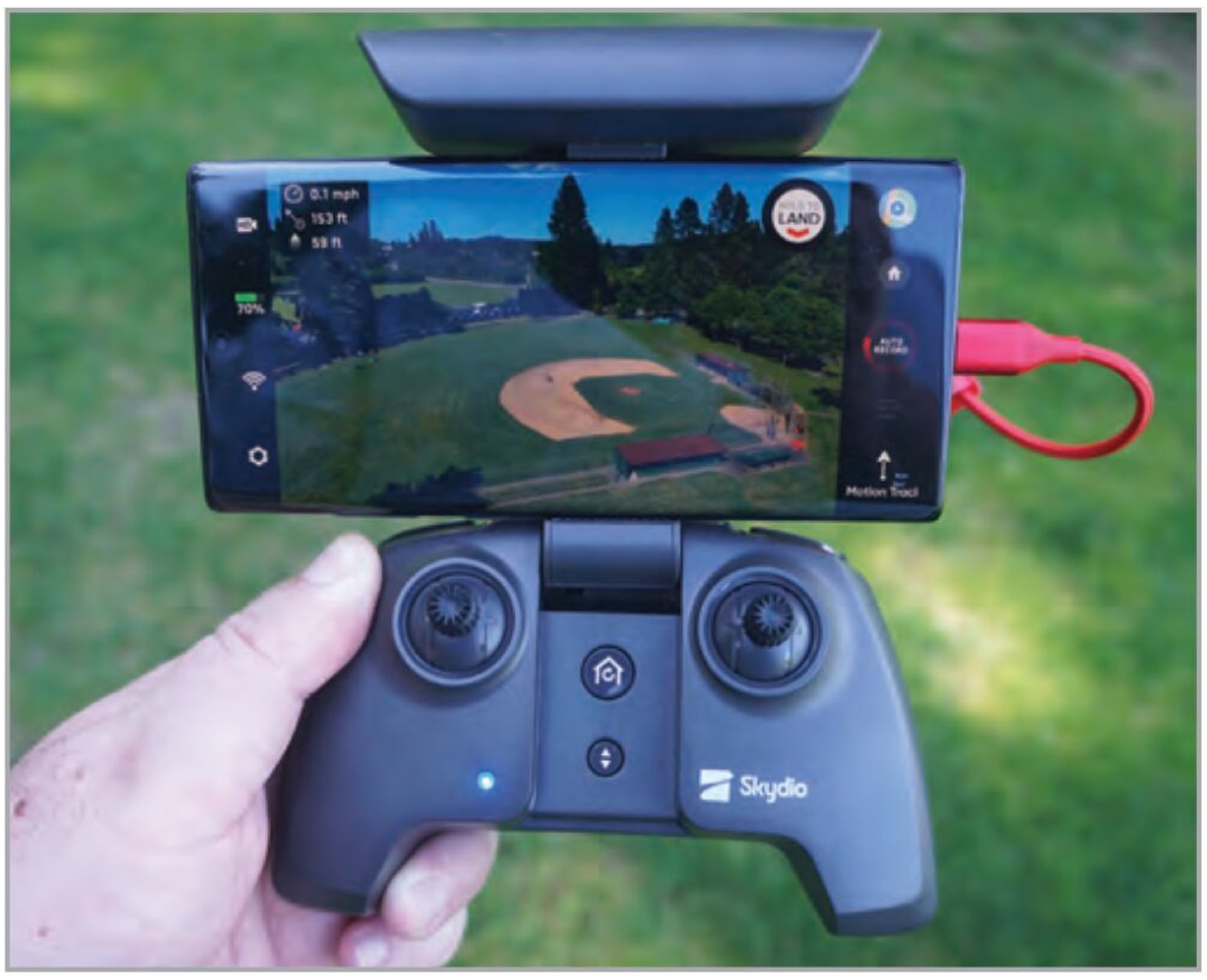
Sensor: Sony IMX577 CMOS

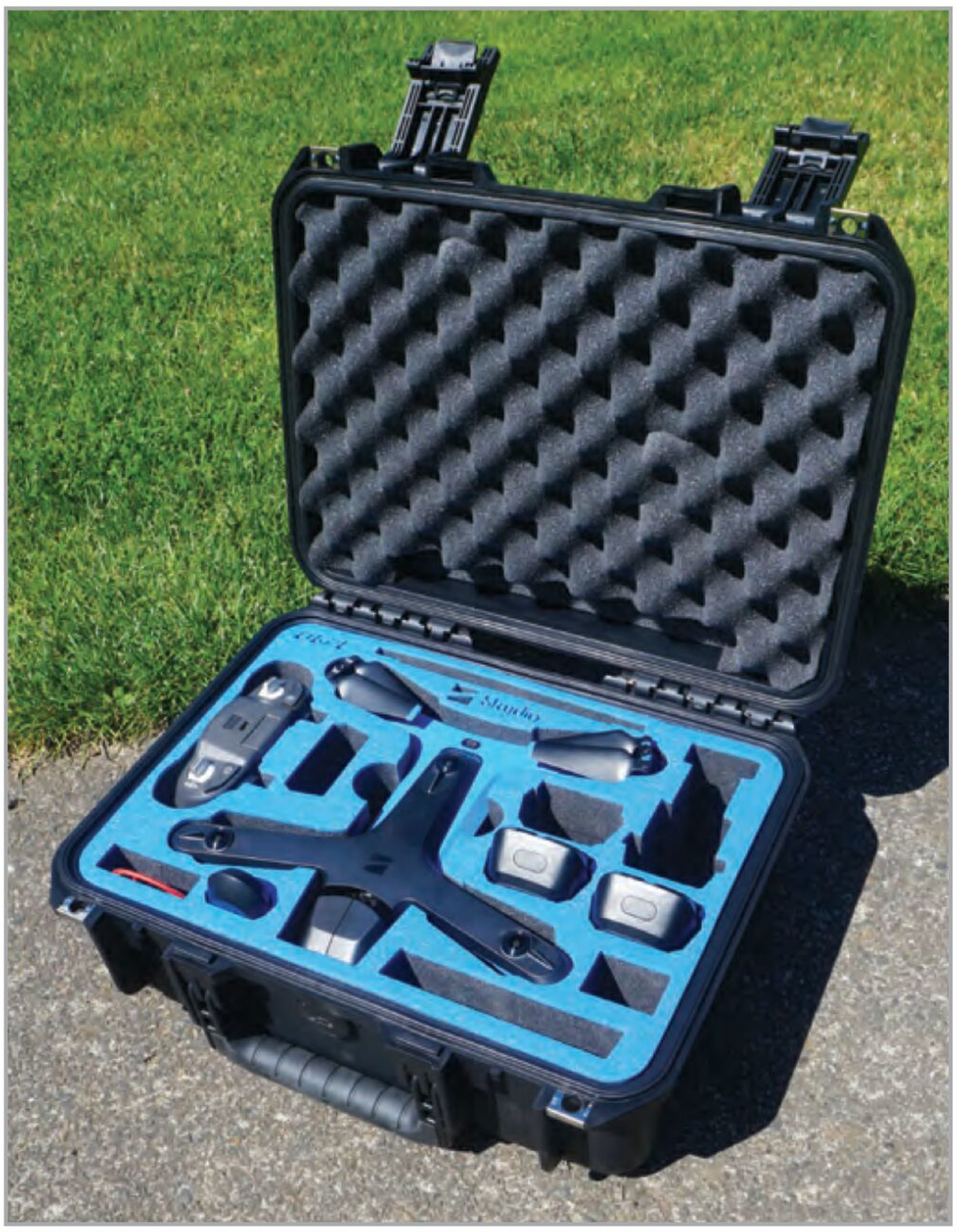
Images: 12.3MP, 4K/30 FPS video

Price: $999.00 (basic package)

FEATURES

- Extraordinary autonomous collision avoidance capabilities
- Camera captures vivid imagery with wide dynamic range
- App uses augmented reality to define maneuvers
- Low price for robust capabilities; made in the USA





Photos By Patrick Sherman

POWEREGG X

To start the PowerEgg X's motors, you use a down-and-in control input on the joysticks and it climbs and maneuvers with confidence. The controller incorporates a physical switch to change to one of three flight modes. The equivalent of Sport mode is engaged when you move the switch to "P," for "Professional" mode. You retain GPS position hold and other advanced features, but the aircraft moves along at a brisk 40 miles per hour. Switch over to "N," for "Normal," and "E" mode, for "Easy," which is downright sluggish compared with the other two and is presumably intended for beginners. Flight time is typical for an aircraft of its size in its base configuration: about 18 minutes under real-world conditions.

The controller, which is included as part of the basic kit, is compact and comfortable in the hand. The PowerEgg X is controlled with the Vision+ 2 app, available for both Android and iOS. It offers a full-featured interface that incorporates telemetry data while leaving ample viewing area for the video downlink.

The aircraft performs well with its optional waterproof shell in place, and is quite content to fly in the rain. The added weight does decrease the flight time slightly, to about 16 minutes on a fully charged battery.

The PowerEgg X incorporates PowerVision's SyncVoice technology, which allows the system to pick up audio from the microphone on your smart device and capture it alongside the video being recorded by the system.

An added bonus, quickly swap out a few parts and the PowerEgg X transforms from a drone to a ground-based smart camera, increasing its utility across a range of applications.

The PowerEgg X is ideal for capturing your adventures or for commercial use, like helping a fire crew respond to a blaze in inclement weather.

495.1
310.4
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QUICK SPECS

Model: PowerEgg X

Manufacturer: PowerVision Robot Inc. (powervision.me)

Size: 683mm x 483mm

Weight: 862g

Sensor: 1/2.8 CMOS

Images: 4K/60P video; 12MP still

Prices: $899 (basic); $1,249 (w/ accessory kit)

FEATURES

- ✚ Capable and full-featured at a budget price
- ✚ Design shows careful attention to details
- ✚ Versatile applications include ground-based imaging
- ✚ With optional accessories can fly in the rain

PowerEgg X
PowerVision

Photos By Patrick Sherman

DJI AIR S2

This top-quality platform provides robust capabilities in both its flight and imaging performance. Incorporating an Automatic Dependent Surveillance-Broadcast (ADS-B) receiver, the S2 will alert you through the DJI Fly app when a crewed aircraft equipped with an ADS-B transmitter is in the vicinity. It has two, forward-facing collision avoidance systems, a rear collision avoidance sensor, and a belly-mounted optical flow system and an infrared altimeter.

The Air S2 is an aircraft that will go where you tell it and stay put when it gets there, thanks to DJI's highly refined flight control system technology, assisted by the fact that it incorporates a three-band global navigation satellite system. Its three-axis gimbal mounts a camera with a one-inch CMOS sensor, capable of capturing 20-megapixel stills and 5.4K video at 30 frames per second. Your interface with the S2 is a conventional two-stick controller connected by a USB-C cable to your Android or iOS device, which provides video and telemetry downlinks as well as control over aircraft settings via the DJI Fly app. The controller itself mounts your smart device above the joysticks.

With sport mode engaged, the Air 2S is an agile, high-performance aerial imaging platform, well-suited to capturing dynamic sports. With resolution down to 4K, you can capture up to 60 frames per second.

Keep in mind that waypoint missions are disabled via DJI firmware on Mavic Air 2S. Because of this, flight apps such as DroneDeploy, and even DJI's own apps, do not allow for waypoint missions.

The DJI Air 2S is ideal for first-time drone operators who want to document their adventures or get into aerial photography.

QUICK SPECS

Name: Air 2S

Manufacturer: DJI (dji.com)

Size: 7.2 x 9.9 x 3 in.

Weight: 595g

Sensor: 1-in. CMOS

Images: 5.4K/30P video/20MP still

Prices: $999 (Basic Package), $1,299 (Fly More Package)

FEATURES

- Superior aerial imaging capabilities in both stills and video
- Robust handling and performance with remarkable stability
- Compact, folding design for easy transportation and storage
- Budget-friendly price for consumers getting into drones

Photos By Patrick Sherman

PARROT ANAFI USA

Parrot's latest drone provides a powerful aerial imaging tool for professionals who need a clear view of what is happening on the ground when lives or big money are at risk. The extraordinary combination of thermal imaging and a visible-light camera with a 32x zoom capability are going to let you see what you need to see, right now.

The Anafi USA has two visible light cameras: one with a 75-degree field of view and the other with a 16-degree field of view, which is the equivalent of 5x magnification. This delivers a smooth and seamless zoom capability from 1x to 32x. From a magnification of 1x to 5x, the imaging system simply crops the image from the wide field-of-view camera. The absolute number of pixels in the image drops—if you capture a still image, for example—but the real-time image on your smart device remains perfectly clear. Then, when you hit 5x magnification, the system switches over to the other camera and the digital zoom process begins again.

At 10x magnification, the camera is still capturing the equivalent of 1080p video (1920×1080 pixels), which drops to 1280×720 at 15x, and then 720×480 at 27x. There is some pixilation in real-time video at 32x, but the quality is sufficient for applications like search and rescue. Except for their lenses, the two cameras are identical: capable of capturing 21 megapixel stills and 4K, high-dynamic range video at 24 frames per second. Each has 1/2.4-inch Sony IMX230 sensors with an F2.4 fixed aperture.

The Anafi USA comes with the SkyController 3, which holds your smart device, and a robust case that has an O-ring seal and locking latches. It also comes with three batteries that can be charged with the included five-outlet USB power supply, so you can recharge all three batteries—and the aircraft controller—simultaneously.

The Parrot Anafi USA is ideal for commercial operators working in tactical environments.

QUICK SPECS

Model: Anafi USA

Manufacturer: Parrot (parrot.com)

Size: 828 x 373 x 84mm

Weight: 449g

Sensors: two Sony 21MP/4K/2.4 visible light; 320x256 FLIR Boson thermal camera

Images: 4K HDR video at 24 FPS (visible light); 21MP still (visible light)

Price: $7,000

FEATURES

- ✚ Powerful suite of imaging tools well-suited for public safety
- ✚ Able to fly in the rain and other adverse environmental conditions
- ✚ Compact, folding design for easy transportation and storage
- ✚ Made in the USA with robust data-protection safeguards

Photos By Patrick Sherman

AUVSI
XPONENTIAL
WELCOME TO
THE XPO HALL
Exhibit Hall C
XPO
HALL HOURS

Xponential 2021

Showcasing the latest in uncrewed flight

Text & photos by Patrick Sherman

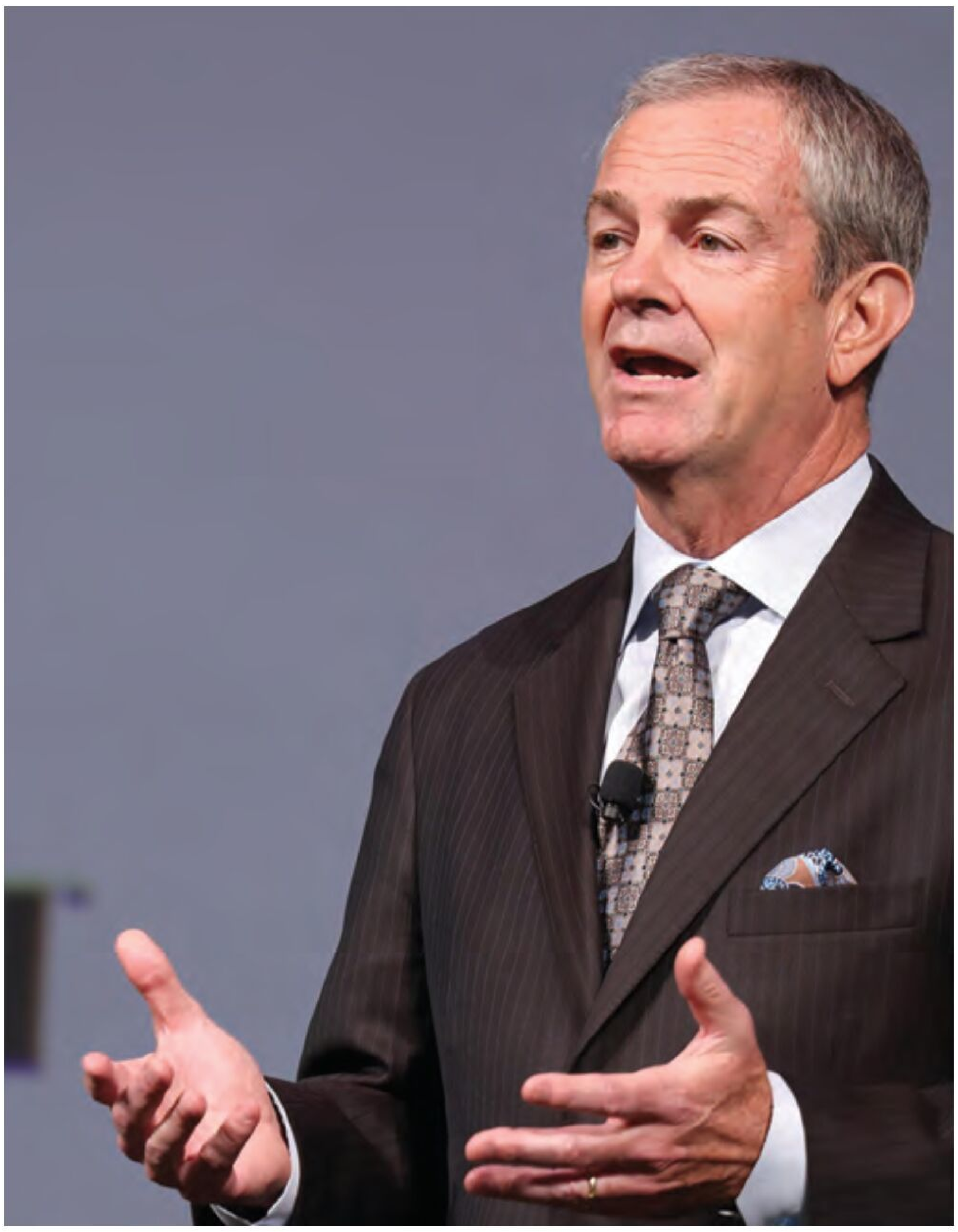
TEXTRON Sys

www.skyfront.com

This year, Xponential began under a cloud—literally. As the 2021 in-person installment of the Association for Unmanned Vehicle Systems International (AUVSI) flagship show began in Atlanta, Georgia, the remnants of Hurricane Fred were passing over the city, bringing heavy rains and blustery weather. It was a real storm, but also an apt metaphor for what the drone industry—and the world—have experienced over the past 18 months.

When COVID-19 arrived in the United States in March 2020, it led to the immediate shutdown of trade shows and industry meetings. Many, including Xponential, moved to online formats, but these were only shadows of their pre-pandemic selves. With the arrival of safe and effective vaccines against the virus in early 2021, the industry looked forward to a better year ahead.

Following the collapse of the long-running InterDrone show originally scheduled the week prior, Xponential was the first out of the gate, holding its live event August 16-19. In reality, it was the second half of the show, the first half having been held online in May—closer to its traditional early-spring date. The in-person event was different from previous years, but revealed an industry anxious to meet in person and eager to share the technological innovations that have emerged from a year in isolation.



AUVSI CEO and President Brian Wynne spoke on the eve of Xponential 2021. (Photo courtesy AUVSI)

The View from the Top

On the eve of the show, AUVSI CEO and President Brian Wynne offered his assessment: "Any time we get our community together it's always action-packed, it's always valuable, and it's always a lot of fun. It's not going to be as big as it usually is, this year. We're without our international visitors for the most part—people are staying away for a variety of reasons, and we don't hold that against them, but we're going to have a substantial number of people here—and they are very excited to be here."

The excitement he described was palpable, with attendees enthusiastically greeting each other like long-lost friends in the hallways, even before the show officially opened.

Wynne went on to say that 18 months of social distancing had given the autonomous systems industry the opportunity to shine.

"During this time, our technology has really shown its strength, for unfortunate reasons," he said. "People had to be at a social distance, but we also needed our supply chains to be more robust. This time of COVID really played to our technology's strengths—and we've got tremendous momentum right now. We want to take advantage of that momentum."

Key to that effort, according to Wynne, is effective advocacy for the industry with regulators, legislators and the public at large. While Wynne describes himself as "fronting the band," he admitted that he and the rest of AUVSI's staff are not the only effective advocates for the uncrewed systems community.

"We have a very robust grassroots program developing, and there is nothing more important than the message being local," he said. "We have our chapter network, and those local chapters have been extremely engaged in reaching out to their state legislatures and even municipal authorities and letting them know: This is a technology you can use to serve your community.

"People who are in the industry are much more credible talking about these things than someone like myself. Legislators are looking for people who are offering solutions to step forward with solutions. We just need to be consistent with the message we are giving them."

To foster this consistency, he unsurprisingly suggested that industry participants join AUVSI—a non-profit, membership organization.

"We're all about convening and connecting people," Wynne said. "Join your local chapter and be as active as you possibly can. I know people have day jobs, but the truth is that there is strength in numbers. AUVSI has been a very robust organization for a long time, and I think we're becoming more robust now.

"The more responsive we are to the general public, the more consistent we are in our messaging, the faster we are going to be able to get to scale in the mainstream."

The FAA's Perspective

Another top-level view of the industry came from FAA Administrator Stephen Dickson, who gave a keynote address at the conference. While Dickson himself comes from a crewed aviation background, having been an executive at Delta Airlines, he disclosed that he has a very personal connection to the uncrewed aircraft systems (UAS) industry.

"One of my sons runs a drone photography business here in Atlanta," he said. "While I didn't teach him to fly—since I'm not a drone pilot myself—I know he will think of me often, since my name is on his Part 107 certificate."

After reflecting on his own private-sector experience

18+

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FAA Administrator Stephen Dickson provided a keynote address to the Xponential audience. (Photo courtesy of AUVSI)

that led him to occasionally express skepticism toward the FAA, he described the perspective provided by his new role: "As FAA Administrator, I see policy and the accompanying regulations as a protective sphere or envelope around the aircraft. The envelope gives the operator a comfort zone within which he or she can be assured of a safe operation before reaching any edge, where safety—yours and the public's—might not be assured.

"For drone integration, we've done our best to allow for as much development and operational work as possible within the existing regulatory framework. But obviously we've had to make changes occasionally to make sure the protective envelope is as robust as it needs to be. We're actually at the point right now where we're bumping up against that envelope, so there are some very important and groundbreaking performance-based rules on the horizon, especially in relation to Beyond Visual Line of Sight operations—BVLOS for short—and drone certification."

Oregon UAS Test Ranges
Oregon Aviation
CENSYS TECHNOLOGIES
Pendleton UAS Range
Proven in Pendleton
Powered by CENSYS
Oregon

Pavilions, like this one from the Oregon Department of Aviation, were a common sight on the show floor at Xponential 2021 as states across the country touted their advantages as a location for new drone-related businesses—including test sites and a skilled workforce.

Dickson wrapped up his speech with a discussion of what he calls "trusted integration." He began: "What is trusted integration? To me that means, we—the FAA, the industry and academia, and the user community—have confidence that we're all on the same page and moving in the same direction to get drones safely and efficiently integrated into the National Airspace System. We trust you. You trust us.

"For the FAA's part, we're building trust by doing our best to achieve consensus when we make rules, and we're making it as easy as possible for operators to follow the rules once they're implemented."

As successful examples of this approach, he cited the Low-Altitude Authorization and Notification Capability (LAANC) and the The Recreational UAS Safety Test—known as TRUST—which was rolled out earlier this year.

Dickson continued: "So now let's talk about how we can gain your trust when making new rules. This is a tough one. I say that because getting us all on the same page when we make new rules is not easy—anyone looking at the number of comments we received in the remote ID rulemaking knows this. There were 53,000, and we read every one.

"But that's a good thing. This is a diverse industry, and there are multitudes of competing interests for business—and for the FAA's attention. At the end of the day, not everyone will get exactly what they want, but we try to find solutions that, hopefully, everyone will agree are best for the industry as a whole."

Floor Show

As always, the beating heart of Xponential was the show floor, where nearly 500 exhibitors, from industry giants—like Airbus, Boeing and McDonald-Douglas—to tiny start-ups, vied for the attention of thousands of visitors. Bearing in mind that AUVSI represents all types of uncrewed systems, from the highest reaches of the atmosphere to deepest ocean depths, and everyplace in between, there were more than drones on display.

Northwest UAV
Simlat
Exhibit Hall BC

Bereft of international visitors and with booths more widely spaced to allow for social distancing, the show floor at Xponential 2021 did not offer the same bustle as in previous years—although enthusiasm and innovation were still very much on display

Airborne systems were once again the predominant type of vehicles to be seen, but there were a fair number of land-based systems, as well. However, seagoing and submersible platforms seemed more scarce than in previous years—although I could only speculate as to the reason why: Are more of them made overseas, and so their manufacturers were unable to attend? Or, are they being drawn away to other, more specialized venues focused specifically on maritime applications?

Another trend I observed was an expansion in the number and size of the state pavilions on the show floor. Arizona, Colorado, Maryland, New York, North Carolina, Ohio, Oklahoma, and Oregon all had booths, touting the resources they could offer drone companies: from test ranges to a skilled workforce. I expect this trend will continue in coming years, as the drone industry expands further and becomes an ever more potent source of jobs and economic development.

Finally, there were the companies that make all of the things that go inside uncrewed systems: the connectors, wires, motors, circuit boards, fasteners, sensors, actuators and the myriad other components that are necessary to make them fly, swim or crawl.

So, with that overview in mind, let's take a look at some of the individual products I had a chance to learn about on the show floor.

Aerospace engineer Sasha Mela stands with her creation: a prototype autonomous crop duster with a maximum take-off weight of 500 pounds, currently under development by Venture Aerospace.

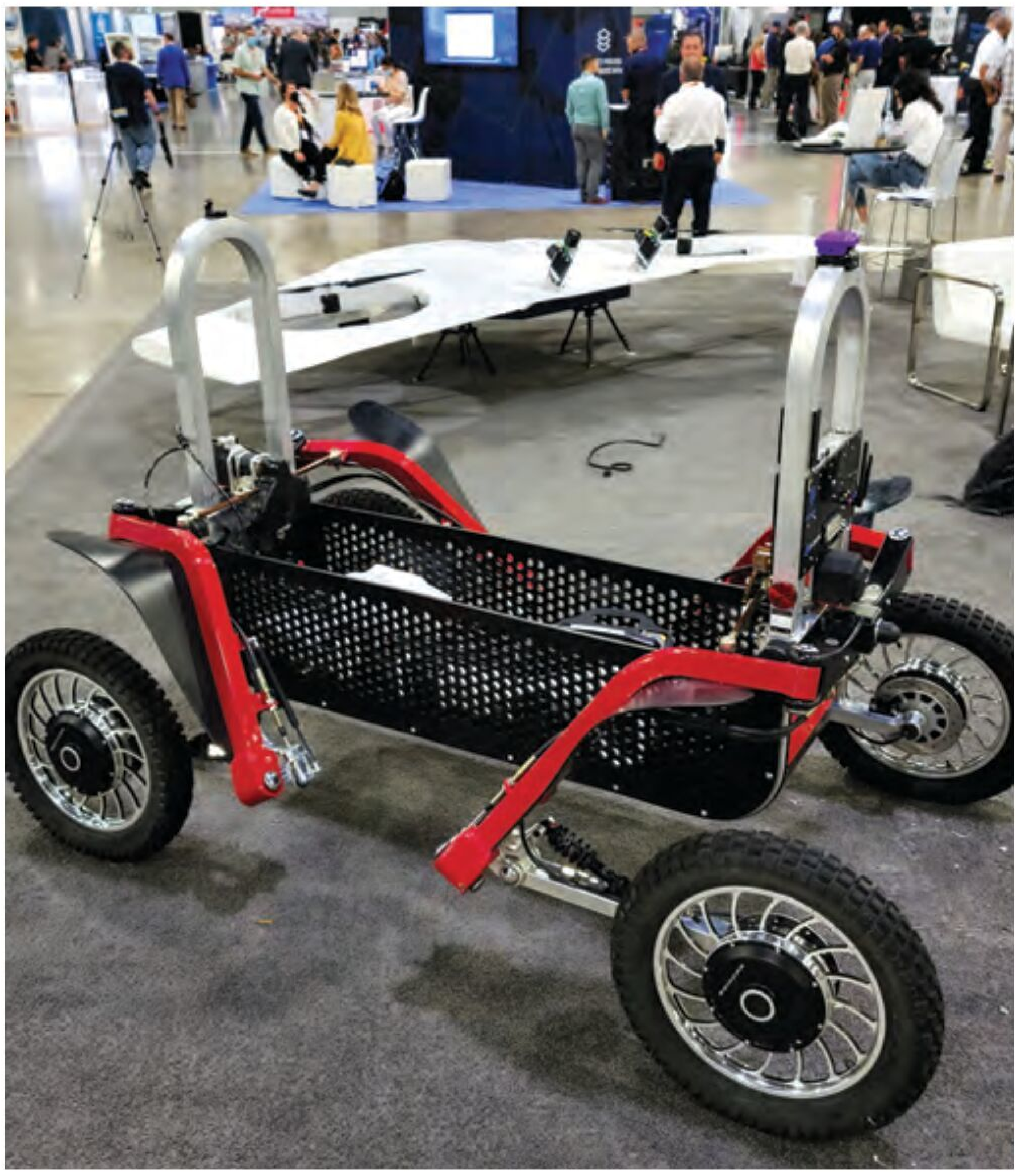
Big Bird

Venture Aerospace captured my imagination unlike any other company I saw at Xponential this year. Its booth measured 20 feet by 30 feet and was given over almost entirely to a working prototype of its only product: a 500-pound crop-dusting drone with vertical take-off and landing (VTOL) capabilities. I'm not sure whether it was the size of the vehicle—which boasts a 16-foot wingspan—or its vaguely homemade quality that most intrigued me.

It was immediately clear that this wasn't a mock-up or a model, but working hardware that had already taken to the sky. Fortunately the lead aerospace engineer on the project, Sasha Mela, was available to explain how it worked to me.

"This version is tethered, and it's connected to our rover, which carries all the batteries," she explained. "We had to make this one in ourselves in our lab—it's our mold, basically. We've proven that it can fly, that this is the shape for our finished aircraft."

The prototype VTOL crop duster being developed by Venture Aerospace flies by means of two large propellers driven by heavy-duty electric motors. However, the final design will incorporate ducted jets powered by a fuel-agnostic diesel combustion chamber.



To power its 500-pound autonomous crop-duster during initial flight testing, the Venture Aerospace team relied on this trolley to carry the batteries necessary to power its electric motors for propulsion and maneuvering, connected to the aircraft by a tether.

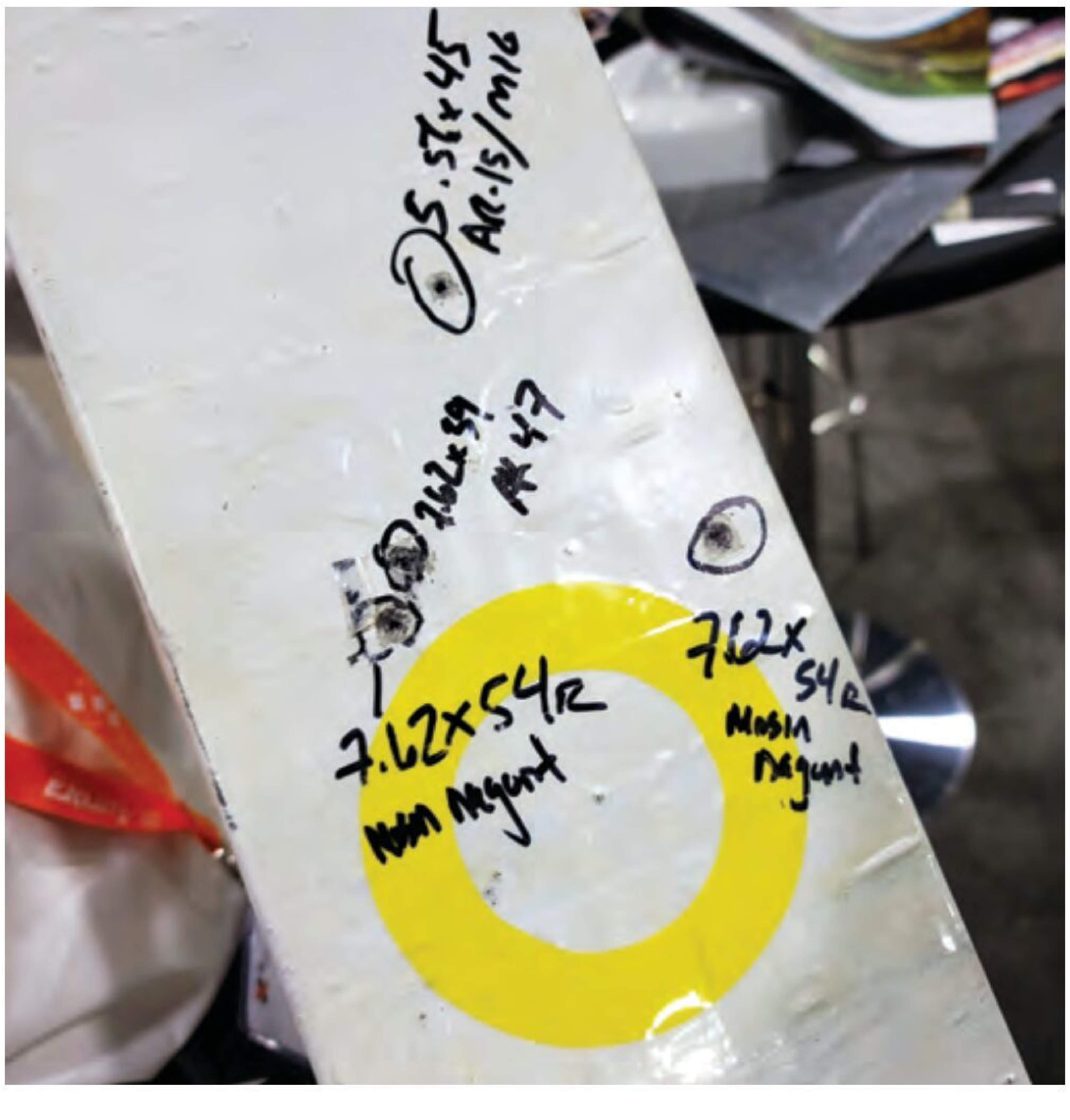
For lift-off and forward flight, the aircraft has two three-foot ducted propellers embedded within the wing structure, driven by powerful electric motors. Four additional motors with smaller propellers mounted at the rear of the aircraft provide pitch- and yaw-maneuvering capability. However, according to Mela, this is only a temporary arrangement for initial testing.

"On the finished aircraft, we're not going to have any propellers," she said. "Instead, we're going to have gimbal-mounted ducts—like a Dyson bladeless fan—that will provide both lift and maneuvering capability."

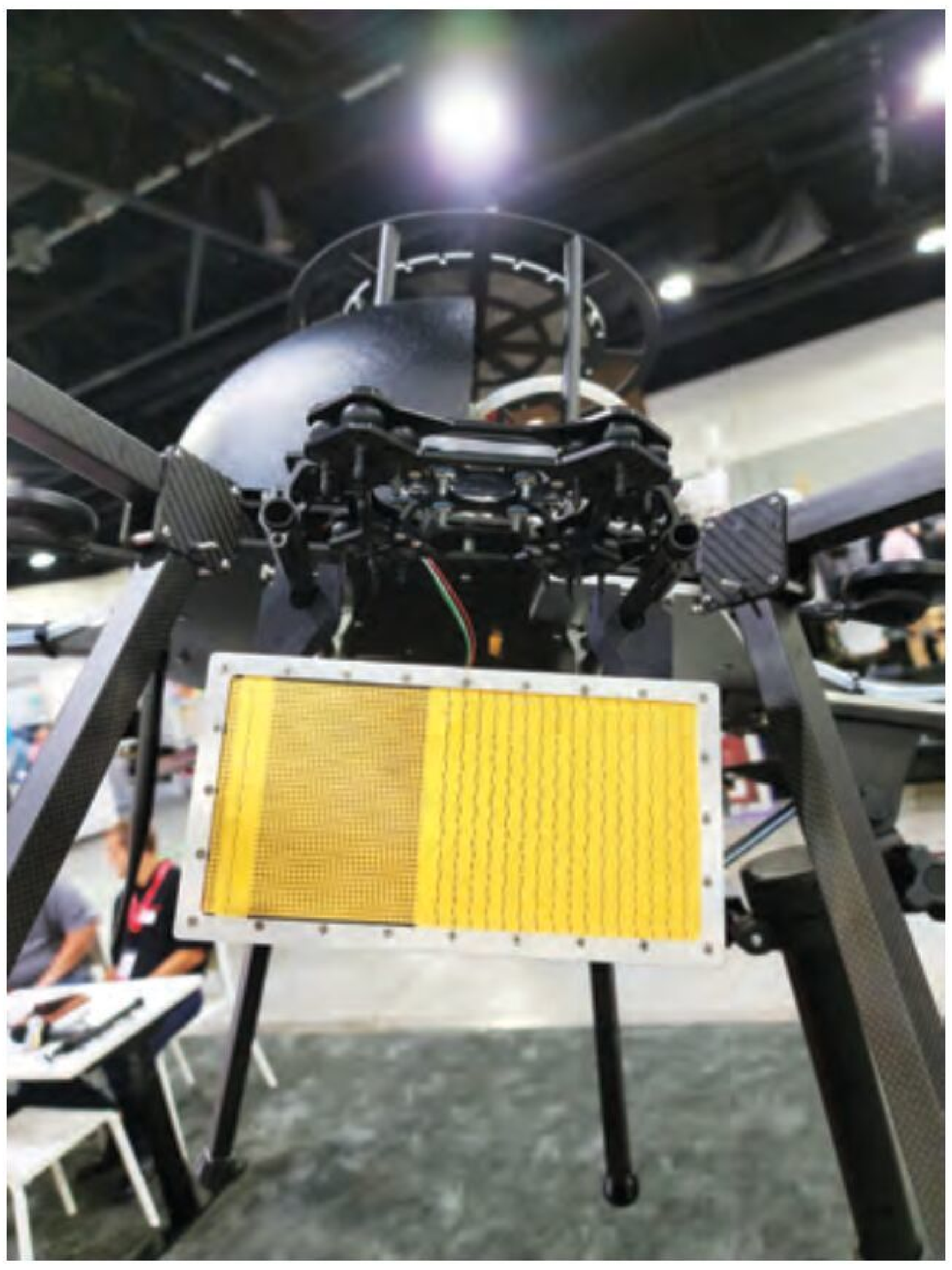
Powering this remarkable machine will be a 3D-printed Inconel combustion chamber. This fuel-agnostic diesel engine will produce thrust that will directly drive the ducts on the wings—eliminating the need to convert the energy created by burning fuel into electrical power by means of an onboard generator, reducing weight and mechanical complexity.

According to Mela, the airframe is made out of a proprietary polyurethane blend that is pressurized and cures in a manner similar to tempered glass. I don't know enough about material science to even speculate about what all that means.

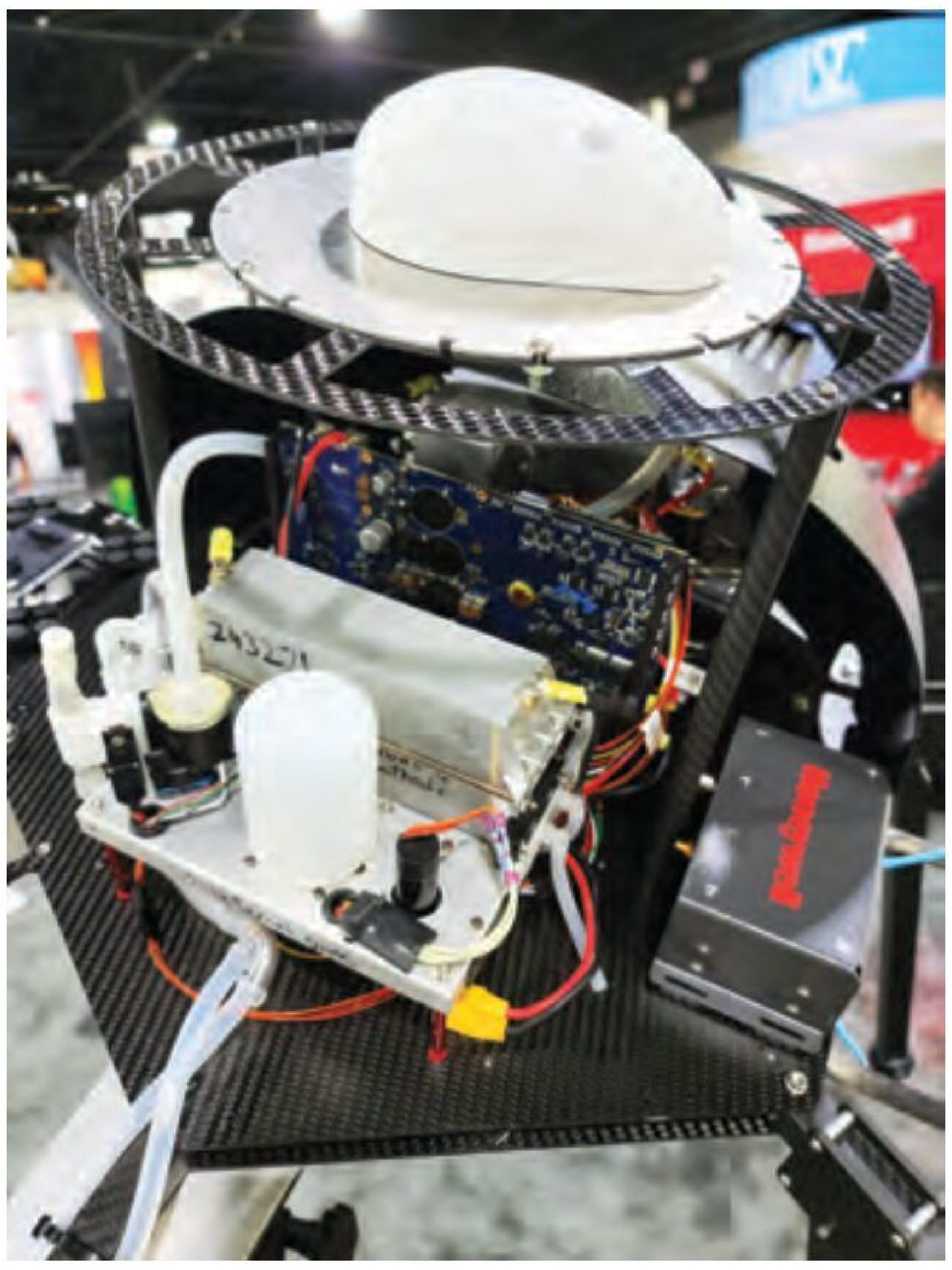
One unique property of this substance, for which she had



To demonstrate that its platform can sustain gunfire, the Venture Aerospace team took a sample of their proprietary polymer to a local shooting range and tested it against a variety of weapons.



Part of Honeywell's Beyond Visual Line of Sight (BVLOS) suite, the RDR-84K is a miniature radar array that provides a 110-degree field of view out to a range of three kilometers—allowing the drone to detect and avoid air traffic and other hazards.



A cutaway shell provides a glimpse inside a multirotor equipped with Honeywell's Beyond Visual Line of Sight (BVLOS) suite, including the hydrogen fuel cell and the satellite communications system.

The hydrogen fuel cell that is available as part of Honeywell's Beyond Visual Line of Sight (BVLOS) suite is liquid cooled, relying on a pair of radiators mounted on the limbs beneath two of its propellers. Not only does it enhance the efficiency of the fuel cell, but it also allows it to operate in more arid climates.

evidence on hand, is that it is essentially immune to small-caliber gunfire and, by the way, I am definitely not making this up.

"We took it down to our local shooting range, and we had them shoot AK-47s and other large weapons at it," she said. "What we learned was that it imparts no energy to the material. The bullet goes straight through, and it doesn't move at all. If our aircraft is flying and being shot at, no one will be able to drop it."

As testament to this claim, she held up a block of white foam with bullet entry and exit points marked on its surface. More than verifying the veracity of her statement, however, I was curious to why this was a consideration in the first place.

She reported that crewed crop dusters come under fire while flying, so it was reasonable to expect that the drone would, as well. Incredulous, I did some research later and found out that, yes, people really do shoot at crop-dusting airplanes. Based on my limited research, I wouldn't say it's a common occurrence, but it does happen—so it's best to be ready for it, I guess.

Suite Success

Aerospace and technology giant Honeywell was on hand with a suite of technology aimed at a single purpose: permitting BVLOS operations. Of course, the regulations to support that at scale are still being worked out by the FAA and the industry, but based on what I saw, Honeywell will be ready on day one. The system consists of four individual components.

First among these is a liquid-cooled hydrogen fuel cell. A fuel cell basically works like a battery, except that it provides power as long as hydrogen gas is available—and since hydrogen gas can be stored in relatively lightweight high-pressure cylinders made of carbon fiber, the technology allows drones to fly for a very long time.

"With a hydrogen fuel cell, you are able to fly about three times as long as you could with an equivalent battery," said Chris Hawley, a customer marketing director with the company.

The next element of the BVLOS suite is a miniature radar array: the RDR-84K, which measures just eight by four inches and provides a 110-degree field of view.

"It can see out to three kilometers, and it has a bunch of different uses," Hawley explained. "It can detect traffic, it can detect obstacles, it can map terrain, it can see weather, it can be used for alternate navigation if your GPS fails, it can be used for landing zone detection, and it can even be used as a radar altimeter."

To provide complete 360-degree coverage, an aircraft can be fitted with multiple radar units. That would allow it to detect other air traffic approaching from behind, for example.

The third element of the system is a satellite communications link, which incorporates an antenna mounted on an exterior surface of the aircraft, as well as internal electronics to process the incoming and outgoing signals.

"Our sat-com receiver is very light, and it's actually the smallest and lightest airborne sat-com receiver on the market right now," according to Hawley. "We figured out a way to stream video with it, so you can operate your drone and see what it's seeing from anywhere around the world."

The final component of the system is a new line of inertial measurement units (IMUs). Every multirotor flying today has an IMU on board. It is essentially an integrated set of solid-state gyroscopes and accelerometers that determine the relationship between the aircraft and the horizon in each axis of movement, as well as how quickly it is changing.

It would be impossible to fly a multirotor without an IMU on board, which provides data to the flight control system (FCS) in order to keep the aircraft stable. With input from the IMU, the FCS makes hundreds of changes each second to the speed of each propeller, even without input from the pilot.

"What sets our new IMUs apart is that they are very sensitive and very rugged, and they can be integrated into multiple systems on the drone," said Hawley.

Pricing was not disclosed at the show—a near-certain indicator that none of this will be cheap—but Hawley invited prospective customers to get in touch through the Honeywell website.

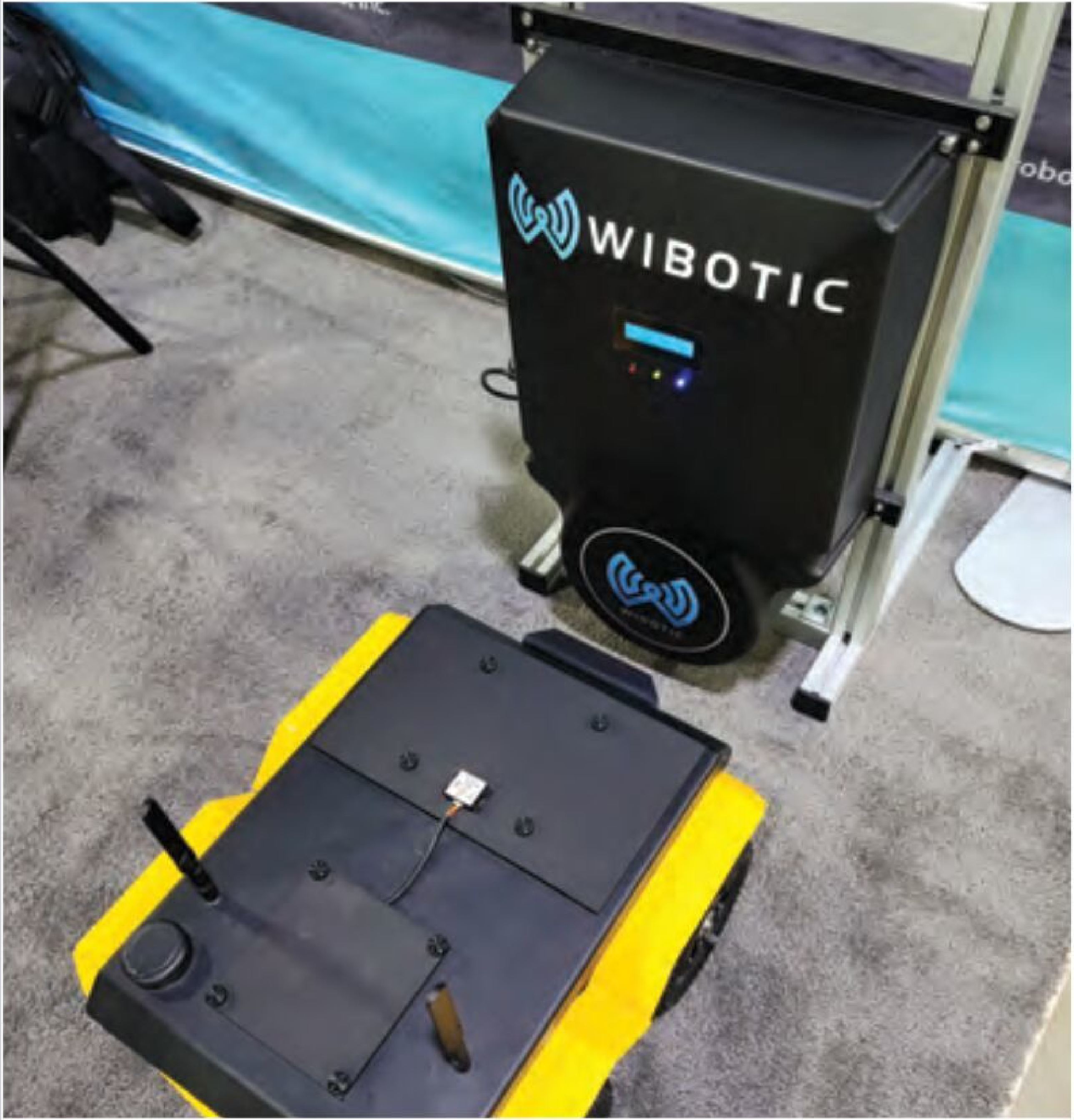
Map and Avoid, All at Once

Light detection and ranging (LiDAR) is a well-known tool for making extremely accurate terrain models when deployed both on board crewed aircraft as well as drones. The system sends out a pulse of laser light and then watches for its reflection from an object in the environment. Divide the elapsed time between those events in half and multiply it by the speed of light, and you achieve an extremely accurate measurement of the distance between them. Repeat the process a few billion times and use a computer to keep track of it all and you end up with a precise, three-dimensional model of the world.

Hovermap, a product from Australia-based Emescent Proprietary Limited takes that fundamental capability to some entirely new places, in a very literal sense. Like most LiDAR systems

When connected to a large, sophisticated drone—like the DJI M210 or M300—the Hovermap LiDAR system from Emesent allows for simultaneous high-resolution 3D mapping as well as real-time feedback to the collision-avoidance system. This allows for autonomous operations in GPS-denied environments and confined spaces, like mines or caves.

Close Only Counts in Horseshoes, Hand Grenades … and Wireless Charging?



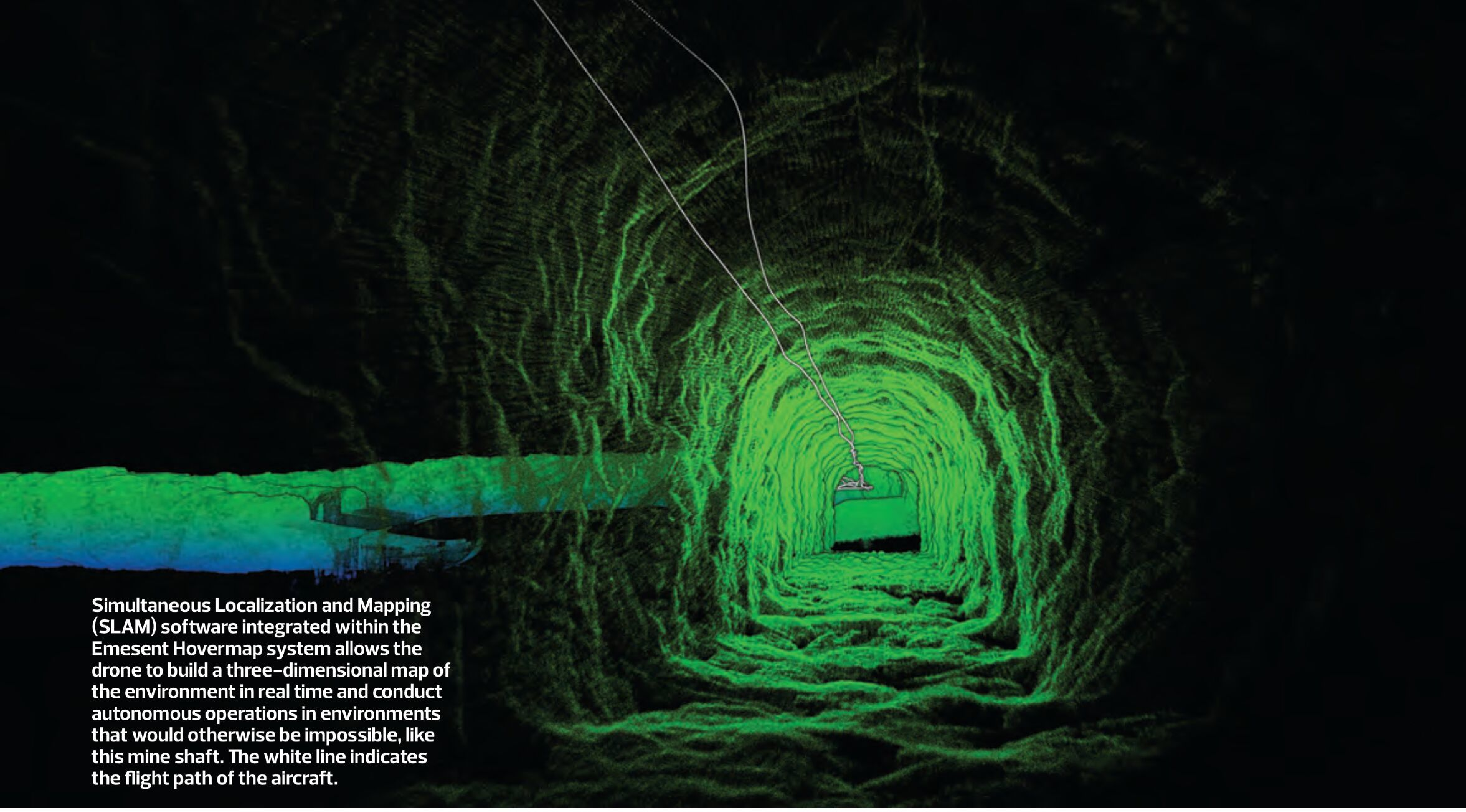
The Wibotic wireless charging system allows autonomous systems, like drones and robots, to recharge by coming close to their base station—without the need for physical contact or precise positioning.

Among the products on display at Xponential 2021 was an innovative wireless charging system from Wibotics. What sets the company's products apart is that they have been designed specifically for use on autonomous systems, like drones and robots, that move autonomously and might not always be perfectly aligned with their charging base at the end of a deployment.

Charging is initiated with a bi-directional radio transmission between the robot and the charger, which establishes both that the robot is in position and ready to take on a charge, as well as its precise distance from the charger. With this information, the charger can determine the precise level of power to deliver the most efficient charge rate across the gap.

Furthermore, no power is wasted by transmitting energy when the robot is not there to receive it, or when its batteries are already fully charged, and the absence of a direct connection means that the components will not wear down through repeated physical contact over time.

Wibotics has even created a passively cooled version of its system that can be used in extreme environments, like deep within the ocean. One such system is currently slated to be deployed by NASA to recharge an upcoming lunar rover.



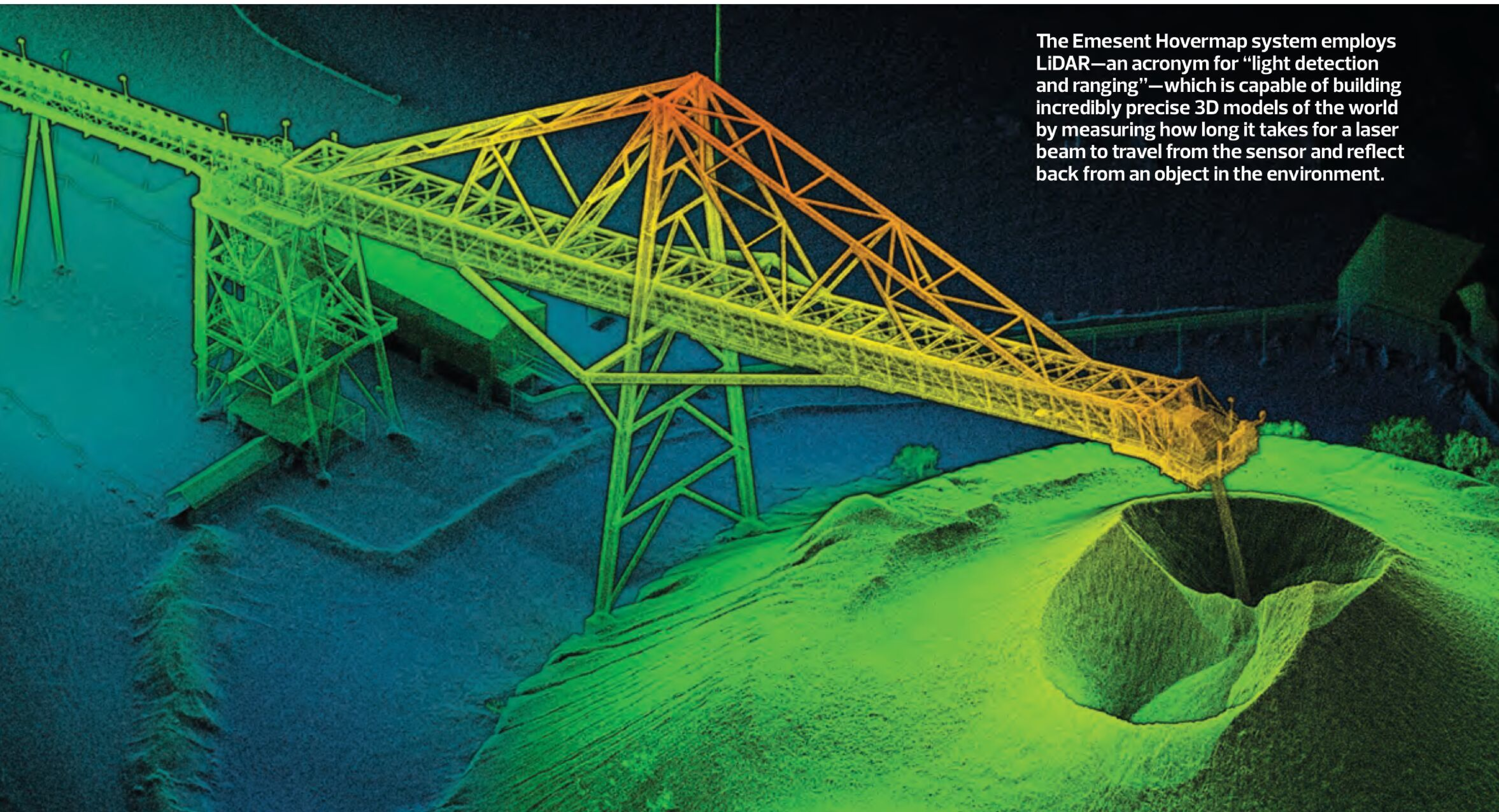
Simultaneous Localization and Mapping (SLAM) software integrated within the Emesent Hovermap system allows the drone to build a three-dimensional map of the environment in real time and conduct autonomous operations in environments that would otherwise be impossible, like this mine shaft. The white line indicates the flight path of the aircraft.

carried onboard drones, the basic sensor package consists of a "puck"—a thick disk that contains an array of rapidly spinning laser emitters and detectors. Unlike other LiDAR sensors, the Hovermap puck itself also rotates.

"Using this approach, you are collecting data at 360 degrees by 360 degrees, all around you," said Jay Shears, a business development manager for the company. "The data is then transferred into a box connected to the unit, where there is a 500 GB hard drive, which allows you to store about 12 hours of data collection.

"Once you have that data, you connect a USB stick to the back of the unit and the data automatically transfer to the stick. Then, you remove the stick and plug it into your computer. Then you drag and drop the file into our processing software. The software will process the data to make it compatible with a number of different relevant software applications."

Dramatically enhancing its capabilities, the same unit can be disconnected from the drone and either carried by hand or on a backpack, to gather additional data—such as the inside of a building that was mapped from the outside using a drone. These datasets can then be integrated to create a seamless model of the entire structure: inside and out.



The Emesent Hovermap system employs LiDAR—an acronym for "light detection and ranging"—which is capable of building incredibly precise 3D models of the world by measuring how long it takes for a laser beam to travel from the sensor and reflect back from an object in the environment.

MicroCalibir: The Best Thermal Imaging Camera for Drones Yet Made!

The MicroCalibir camera core from Teledyne DALSA is ideally suited for use on small drones, offering many advantages over previous generations of thermal imaging systems.

In May of this year, Teledyne Technologies concluded its acquisition of FLIR Systems, the renowned thermal-imaging camera manufacturer that has played a pivotal role in bringing these capabilities to small, civilian drones. The fruits of that partnership were on display at Xponential 2021 as the combined company revealed its MicroCalibir series of camera cores.

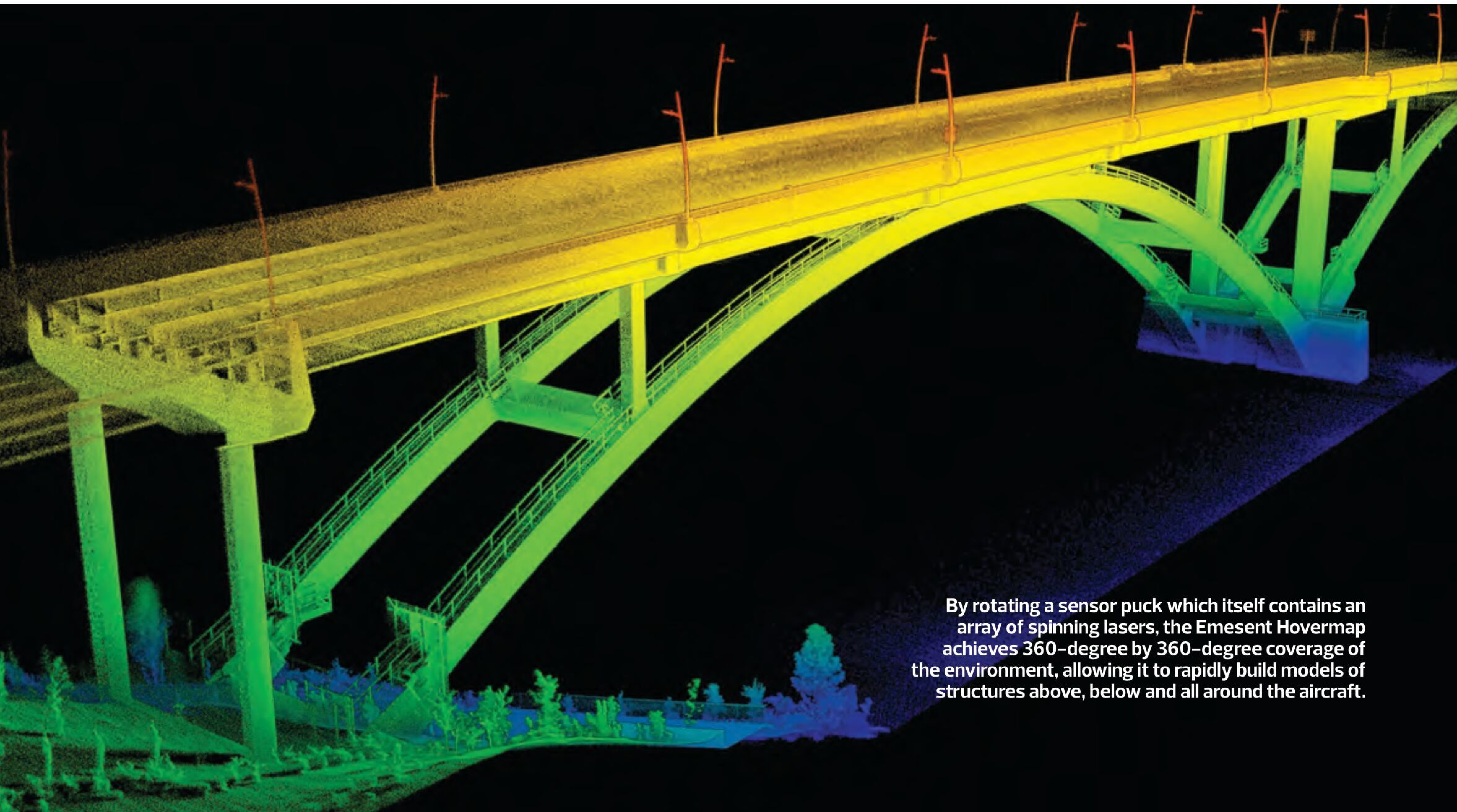
The smallest thermal camera core in the world with a 21x21mm sensor, MicroCalibir cameras are capable of capturing images up to 640x480 pixels and benefit from an extended range, being able to accurately measure and display temperatures up to nearly 2,000 degrees Fahrenheit, making it particularly well-suited to applications such as firefighting and high-temperature industrial inspection.

Weighing as little as 50 grams depending on its lens configuration and requiring minimal power to operate, the MicroCaliber is extremely well-suited to use on small drones. Also, being manufactured by Teledyne DALSA in Canada, the camera faces fewer export restrictions than a comparable core made in the United States, which should increase its availability worldwide.

The unit itself is not small; it's about 18 inches long and weighs about four pounds. However, when mounted on a DJI M210, M300 or M600 it can do more than map: it can dramatically enhance the drone's autonomous navigation capabilities.

"When it's connected to the drone, you can be up and flying in 60 seconds," Shears said. "Then, you have three options. One option is no autonomy. Using the second option, the pilot retains direct control, but the drone has collision avoidance protection using simultaneous localization and mapping (SLAM) software. What that does is collect all of the features in the surrounding environment, and it uses that information to recognize where it is, so you don't need GPS. You can fly in a GPS-denied environment, but it also provides you with collision avoidance.

"The third option allows you to fly fully autonomously, and SLAM uses the information to navigate the aircraft and also uses the information to provide collision avoidance. On the user interface, you can just set a waypoint, click tap to fly, and the drone will head towards that waypoint. Using the SLAM data, will find a way to get to that



By rotating a sensor puck which itself contains an array of spinning lasers, the Emesent Hovermap achieves 360-degree by 360-degree coverage of the environment, allowing it to rapidly build models of structures above, below and all around the aircraft.

Earlier this year, Skyfront achieved a new world record for multirotor flight endurance with a Perimeter 8 drone like this one: more than 13 hours, while covering 205 miles.

waypoint through different tunnels. It remembers where it has gone, so if there is a fail-safe or return-to-home incident, it knows how to come home without using GPS, and it returns by the exact same path using its own collision avoidance.”

That's a formidable capability, and a reminder that in the future being a skilled drone pilot will involve a whole lot more than having nimble thumbs.

News from the Front

Of all the battles that the drone industry has fought over the last decade, one of the most crucial has nothing to do with regulations or public perception. Instead, it is a fight against time itself, and how to sustain a multirotor in the air for as much of it all possible. Over the past year, the industry has been startled by breakthroughs announced by Skyfront, in this regard.

In March, the company announced that one of its Perimeter 8 gas-electric-hybrid drones had established a new world record by flying for 13 hours and four minutes, covering a total distance of 205 miles in the process. The company's CEO, Dr. Troy Mestler—who holds a Ph.D. in physics from Princeton—was on hand at Xponential to talk about his company's achievements.

“On that record-breaking flight, we took off before sunrise, and we landed after sunset, and we captured all of it on camera from on board the UAV,” said Mestler. “We convert gasoline into electricity in flight. The idea behind it is that we want to take advantage of the awesome multirotor technology that has been developed over the last 15 to 20 years—the [electric speed controllers], the motors, the propellers—but we didn't want a direct-drive system like a conventional helicopter. However, we also wanted the extended range and endurance that batteries can't provide.”

To be sure, gas-electric hybrid multirotors have been available for years and have achieved flight time that far outstrip their battery-powered counterparts, but none have achieved results anywhere close to what Skyfront has achieved. Mestler explained that it was not the result of any singular breakthrough, but careful attention to a multitude of tiny details.

“It comes down to the fact that we made a ton of

While there have been a number of previous examples of gas-electric hybrid multirotors, none of have matched the refinement—or the capabilities—of the systems designed by Skyfront.

improvements. For example: we manufacture the power source, we manufacture the airframe, we manufacture the engine control unit—and because we own the entire technology stack, we can make 1 to 2 percent improvements everywhere across the board, and those things add up over time."

While I don't have the engineering know-how to assess Mestler's explanation in detail, I can say that examining his aircraft in person, I was impressed with the level of refinement on display. Every other gas-powered multirotor I've ever seen looks like it's got a leaf-blower engine bolted to it. In the case of the Skyfront aircraft, however, the engine and generator were compact, streamlined and fit nicely within the overall design.

In terms of the missions, these aircraft are payload agnostic. Meslter reports strong interest from land surveyors owing to their ability to carry robust, and heavy, LiDAR sensors for several hours at a time, as well as security officials, particularly overseas, who have equipped them with cameras for surveillance missions.

Initially, I was incredulous at the thought of a gas-powered surveillance drone, since those I have previously seen—and heard—are about as subtle as your neighbor's lawn mower at 7 a.m. on a Saturday morning.

"We've spent a fair amount of time muffling the vehicle and understanding its sound signature," Mestler explained. "That way, the operator knows when it can and cannot be heard. During our training sessions, we advise the pilot how to fly it so that they can evade detection.

"At about one kilometer, you can start to hear the vehicle, but it's very faint. However, since we can carry such heavy payloads, it's easy to use a camera with a powerful zoom lens that lets you keep an eye on a subject from one kilometer away."

The Best Defense

With the rapidly increasing capabilities of drones, the possibility that they will be used for mischief—or worse—is greater than it has ever been, and only expands with each passing year. As at previous shows, counter-UAS technology was again on display at Xponential in 2021, although one company stood out from the rest: D-Fend Solutions.

To date, the CUAS mission has been achieved by one of two basic approaches: jamming and interceptors, but each have their own drawbacks. Jamming a drone also wipes out everything else in the vicinity that relies on the same radio frequencies—including WiFi, cordless phones, GPS and countless other modern conveniences—and may also cause the drone to behave erratically, possibly increasing the hazard it was intended to mitigate.

Interceptors use nets to physically capture and restrain rogue drones, but they are necessarily larger and heavier than their prey, making it a serious challenge if their target is hovering over a crowd of people, for example. Also, a near-miss by an interceptor could send the intruder tumbling out of the sky, again with the potential to make a bad situation worse.

D-Fend Solutions has come to market with an entirely new approach, as Jeffrey Starr, the company's chief marketing officer, explained: "Our technology is based on radio-frequency, cyber take-over of intruding drones. We detect the communications between the remote control and the drone, and then we literally take over the drone and push it along a safe route to a safe landing in a pre-designated zone to reduce the danger.

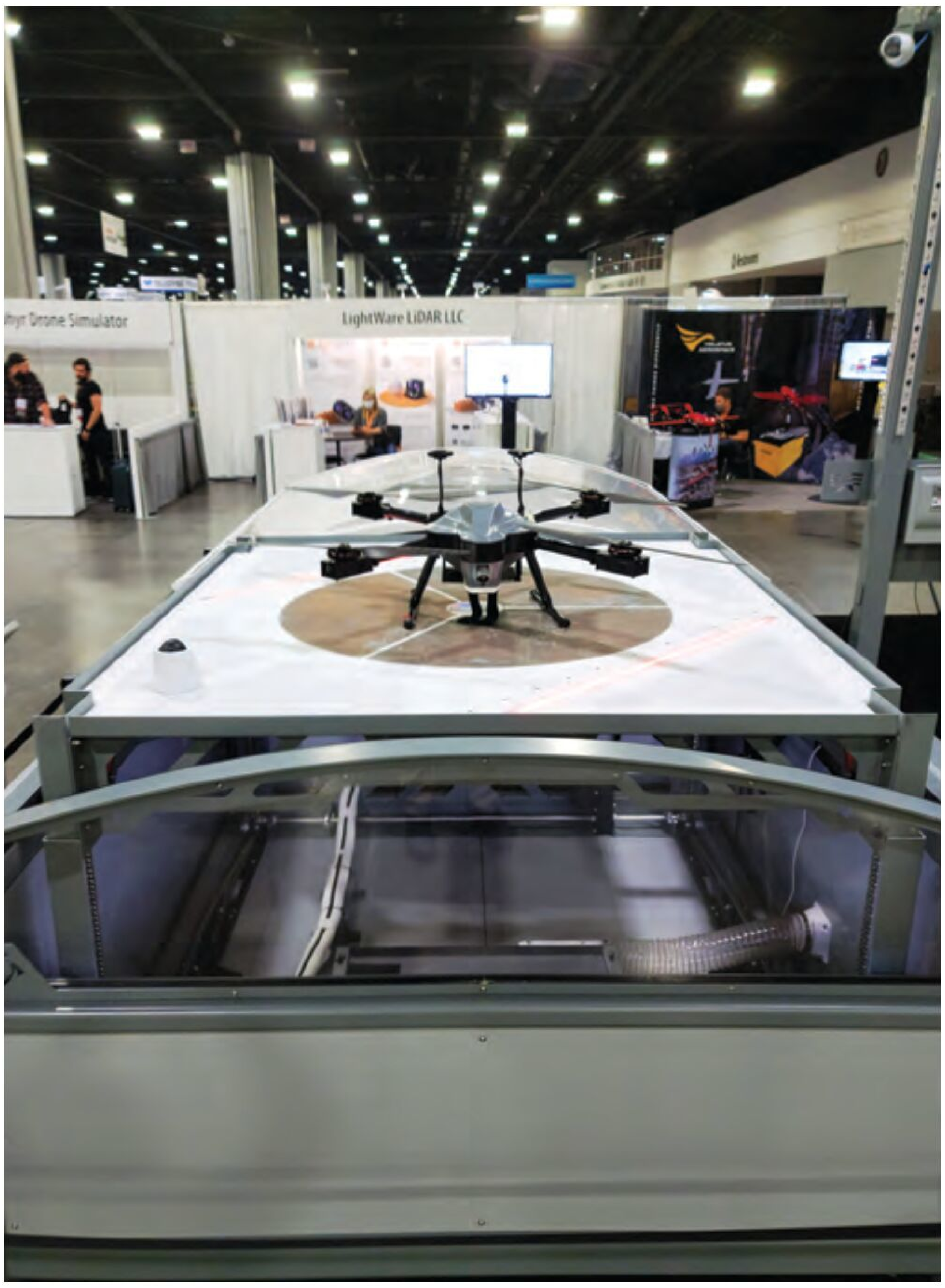
"Alternatively, we can do what is called a fend-off, which sends the drone back where it came from. We can even cause it to hover

The D-Fend Solutions EnforceAir, the company's flagship anti-drone product, detects, locates and identifies rogue drones in airspace and then neutralizes the threat by allowing you to take full control over the drone and land it safely in a predefined zone. (Photo courtesy D-Fend Solutions)

in place, but it's basically a system based around continuity, control and safety."

As you would imagine, the core component of this system is an array of antennas connected to sophisticated radio gear, all directed using a computer interface. The system contains a database of communications signatures and protocols for numerous different types of drones and is constantly being updated.

"We realize that there are both the nefarious and also the careless when it comes to rogue operators—we want to help security agencies safeguard sites and people against them, while enabling good drones to continue operating and thus helping support the new drone economy," said Starr. "We love drones. What we are doing is seeking to preserve continuity: we want operations, communications, transportation and everyday life to continue, while detecting and mitigating potentially hazardous drones."



Previously only seen in a miniature diorama, the FIRST iZ drone port was on display as a fully functioning prototype, which will soon be launching autonomous aircraft to an emergency ahead of first responders, to provide them with a view of the scene even before they arrive.

That focus on continuity is what sets D-Fend Solutions apart. If a jammer is used to protect a large, outdoor sporting event, for example, it will disable any hostile drones that are detected in the vicinity, but it will also interfere with drones that are there serving a beneficial function: such as providing security or aerial video of the event. Rather than a shotgun scattering pellets everywhere, striking friend and foe alike, D-Fend Solutions offers the pinpoint accuracy of a sniper rifle—eliminating recognized threats while allowing other drones to continue their missions unaffected.

Back for Round 2

As a journalist who has been covering the civilian drone industry basically since its inception, I've witnessed the rise of a few remarkable products and companies over the years that have survived and ultimately

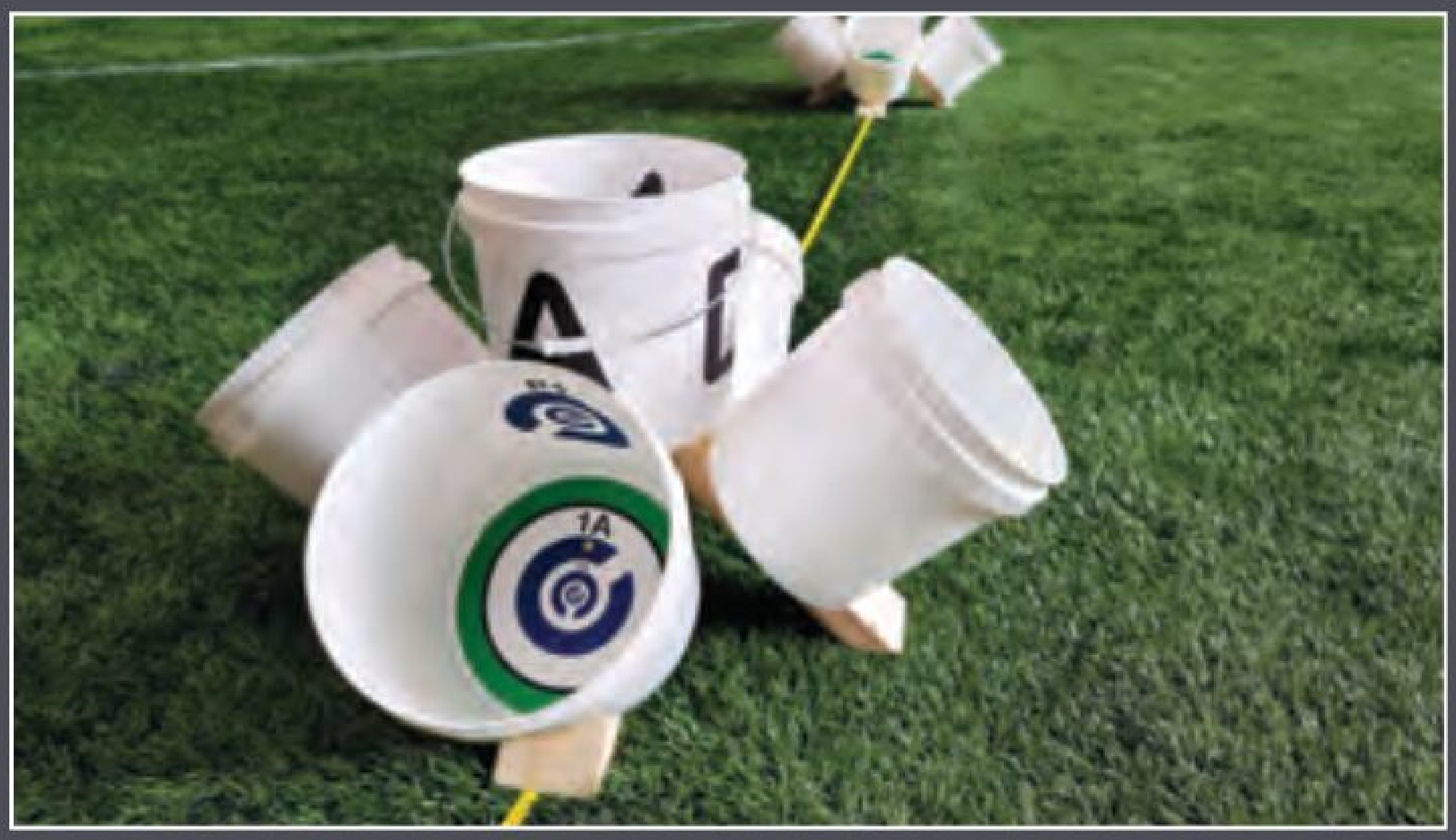
Bucket List: A Standard Method to Test and Evaluate Drone Pilots

On the first day of Xponential 2021, the National Institute of Standards and Technology (NIST) partnered with the DroneResponders Public Safety Alliance to demonstrate its pilot proficiency testing apparatus. Made from a few simple components available globally—such as lumber, bolts and five-gallon buckets—the apparatus allows organizations to establish a benchmark for drone pilot proficiency.

Essentially an "obstacle course" for drones, variations on the NIST standards are already employed by certifying bodies such as the AUVSI Trusted Operator Program (TOP) and the Airborne Public Safety Association (APSA) Basic Proficiency Evaluation for Remote Pilots (BPERP).

The event was held at Mercedes-Benz Stadium, home to the Atlanta Falcons, and gave attendees the opportunity to become familiar with the standards. By employing standardized tests, it is possible to compare the performance of drone pilots all around the world on a level playing field, or the performance of a single pilot across time.

At its most basic level, the NIST testing apparatus serves as a sort of skills test to complement the knowledge test drone pilots are required to pass in order to earn a Part 107 certificate. Effectively, these standards serve as a "check ride" for drone pilots, verifying their ability to actually operate the aircraft in real-world conditions.



With some lumber, five-gallon buckets and basic hardware, NIST apparatus like this makes it possible to establish a benchmark for drone pilot skills that can be compared worldwide and through time.

Mercedes-Benz Stadium, home to the Atlanta Falcons, was the venue for a NIST evaluation apparatus demonstration held on the first day of Xponential 2021. The domed arena offered a welcome respite from the sweltering outdoor heat and humidity.

Only a few maritime autonomous systems were on display at Xponential 2021, including this example of the Remote Environmental Monitoring UnitS (REMUS), designed by the Oceanographic Systems Lab at the Woods Hole Oceanographic Institute.

flourished by offering powerful new capabilities to the market. However, for each one of those, I've seen maybe a dozen others with no shortage of insight, courage and clever ideas which nevertheless have fallen by the wayside.

It isn't the most uplifting part of the job, to be sure, but it's a reality I've come to understand—and expect. For example, when I encountered FIRST iZ and its charismatic CEO Phil Burks at a show in 2019, the company had a small booth and a shoebox-sized model of an autonomous drone launch-and-recovery system.

Burks's goal was to create an aerial scout that would fly out ahead of first responders to the scene of an emergency and provide real-time video before they arrive, allowing them to better assess the scene and ensure that they have appropriate resources to mitigate it. It's a legitimately good idea, but I had my doubts. As I packed up my gear and walked away from my interview with him, I found myself thinking: "That's pretty cool. I wonder if I'll ever see those guys again."

Well, I did, at Xponential 2021—only this time, the miniature mock-up had been replaced with a full-sized, functioning autonomous launch and recovery bay, and a pair of convincing aircraft: a large multirotor and a VTOL fixed-wing platform with folding wings like a carrier-based, crewed aircraft. I can assure you, I was duly impressed.

"There was skepticism—there always is," said Burks. "We are what the financial people call MVP: minimum viable product, and we have four of them. We have a port that can house the drone, that is temperature controlled and has a patented charging system, so the drone can re-charge between deployments. We have a tower that can house radar, a weather station and communications gear, and we have our two aircraft."

Those accomplishments have been sufficient to draw the interest of investors, putting the company at the cusp of actually deploying its system.

"We are in the middle of a seed round of raising money right now. When we get that, which is going to be very, very soon, we are going to put together 20 of these systems," Burks explained. "We are going to put them in hot, cold, wet, dry—places that are already involved in the drone Integration Pilot Program (IPP)—so that they

Xponential 2021 began as the remnants of Hurricane Fred were passing over Atlanta, bringing wet, windy weather to the city that is too busy to hate.

Every year at Xponential, AUVSI announces its Xcellence Humanitarian and Public Safety Award winners. This year's six winners are leaders in using drones as solutions-providers and have made a significant impact using uncrewed systems. They will each receive $1,000.

"These organizations responded to the challenges brought forward due to the global COVID-19 situation by bringing to light even more critical safety uses for UAS," said Brian Wynne, AUVSI President and CEO. "These organizations show that UAS are the future of not just commerce and the economy but are also becoming the primary tools relied on for disaster relief, firefighting, and other critical public safety and health emergencies."

Humanitarian Project/Program

- ALTI UAS (Pty) Ltd., ALTI Unmanned Aircraft Systems Operation Blacktip, ALTI Flying in Misool
- MissionGO, MissionGO Completes Longest UAS Human Organ Delivery Flight
- UNICEF African Drone & Data Academy (ADDA)/Virginia Tech, African Drone & Data Academy (ADDA)

Public Safety Project/Program

- Department of Homeland Security FEMA (Region IV), Travis Potter - UAS Coordinator, Response Division I FEMA Region IV
- Easy Aerial, Easy Aerial Smart Air Force Aerial Monitoring System
- International Emergency Drone Organization, IEDO Best Drone Practices Report for Fire & Rescue services

Although Xponential has seen a huge increase in the number of small, civilian drones on display over the past several years, there are still plenty of reminders on hand that the event had its start as a showcase for autonomous military hardware. This Martin UAV V-BAT 128 was a prime example. A VTOL platform, it is capable of launching from almost anywhere and then transitioning to fixed-wing flight and staying aloft for 11 hours carrying a 25-pound payload.

Xponential is hosted by the Association for Unmanned Vehicle Systems International (AUVSI), so the show is by no means limited to autonomous aerial systems. One reminder came in the form of this heavy-duty firefighting robot from Textron subsidiary Howe & Howe.

can run them and test them and really knock the dust off them.

"Simultaneously, we're going to begin the manufacturing process. Hopefully, we just have minor changes as we go. The software is done, the drone is done, and the port is done—now all we have to do is get out there and knock the dust off of it."

One thing that hasn't changed from when I first met Burks was the clarity of his vision and what he hopes to achieve using this technology: "The Federal Communications Commission (FCC) came up with a study in 2016 that said if we could shave one minute off of every 9-1-1 call, that would be the equivalent of saving 10,000 lives—and that's what our system is going to enable: saving time, saving lives and saving money at the last."

Looking Ahead to 2022

AUVSI has already announced the dates for next year's show: April 25 to 28 at the Orange County Convention Center in Orlando, Florida. A map of the show floor reveals that many of the industry's leading companies have already committed to participate, including AeroVironment, Textron Systems, NAVMAR Applied Sciences Corporation, Airbus, Freefly Systems, Autel Robotics, and Skydio, plus a myriad of others, large and small.

In addition, states including Ohio, Colorado, Virginia, Oklahoma, North Dakota, Maryland, and Arizona have already reserved space for state pavilions, as have Norway, Spain, and Switzerland. One whole corner of the show floor has been set aside to feature maritime solutions and there is a large space labeled "Sandbox Collaboration Area," which I sincerely hope will include an actual sandbox.

The best part is that we won't need to wait a whole year to attend. By moving the show back to its traditional spring schedule, AUVSI has ensured that you will only need to wait for about five months from now to catch your next glimpse of the future of the uncrewed systems industry.

LEARNING TO SPEAK AVIATION

Enhance your situational awareness

By David Ison

If you have ever listened to crewed aircraft pilots communicating with one another or with air traffic control, much of the conversation may sound almost like a foreign language. Alpha bravo this, midfield downwind that. Niner? Like a forty-niner? What does all this mumbo-jumbo mean? You may be thinking: "Who cares? I'm not a crewed aircraft pilot." That may be true for many of you, but the fact is that you can glean a lot of information about aircraft activity in your vicinity, especially if you are operating (with permission) in areas nearby manned aircraft. Your situational awareness—the knowledge of what all is going on around yourself—can be greatly enhanced by monitoring aviation radio frequencies in use at nearby airports and other facilities. In fact, it is often advocated that drone pilots carry an aviation radio with them for this purpose. I'd even argue it should be a required piece of equipment, but as of right now, it's not mandated as such. So perhaps now you're thinking, "Hey, that actually sounds like a good idea, but where do I start?" Well, let's dive in and see how aviation radio communication works and how to decipher the common language and terms used on the airwaves.

First a caveat, though. While listening

to aviation radio frequencies is a great idea, transmitting (i.e., talking) on them is a no-no unless you are properly licensed to do so. So you might be tempted to go out and buy a fancy transceiver (a radio that can transmit and receive) or try out your skills at aviation lingo outlined here, but think again. The Federal Communication Commission (FCC) regulates all this stuff, and they don't want just anyone jamming up aircraft radio communications willy-nilly. Unless you are a certificated manned aircraft pilot, you will need a stand-alone radio operator's license. It's not hard to get, but you will want to do so prior to pushing transmit. Interestingly, the operator's permit granted to manned aircraft pilots is only good in the U.S., and pilots also need a special permit to transmit outside U.S. borders.

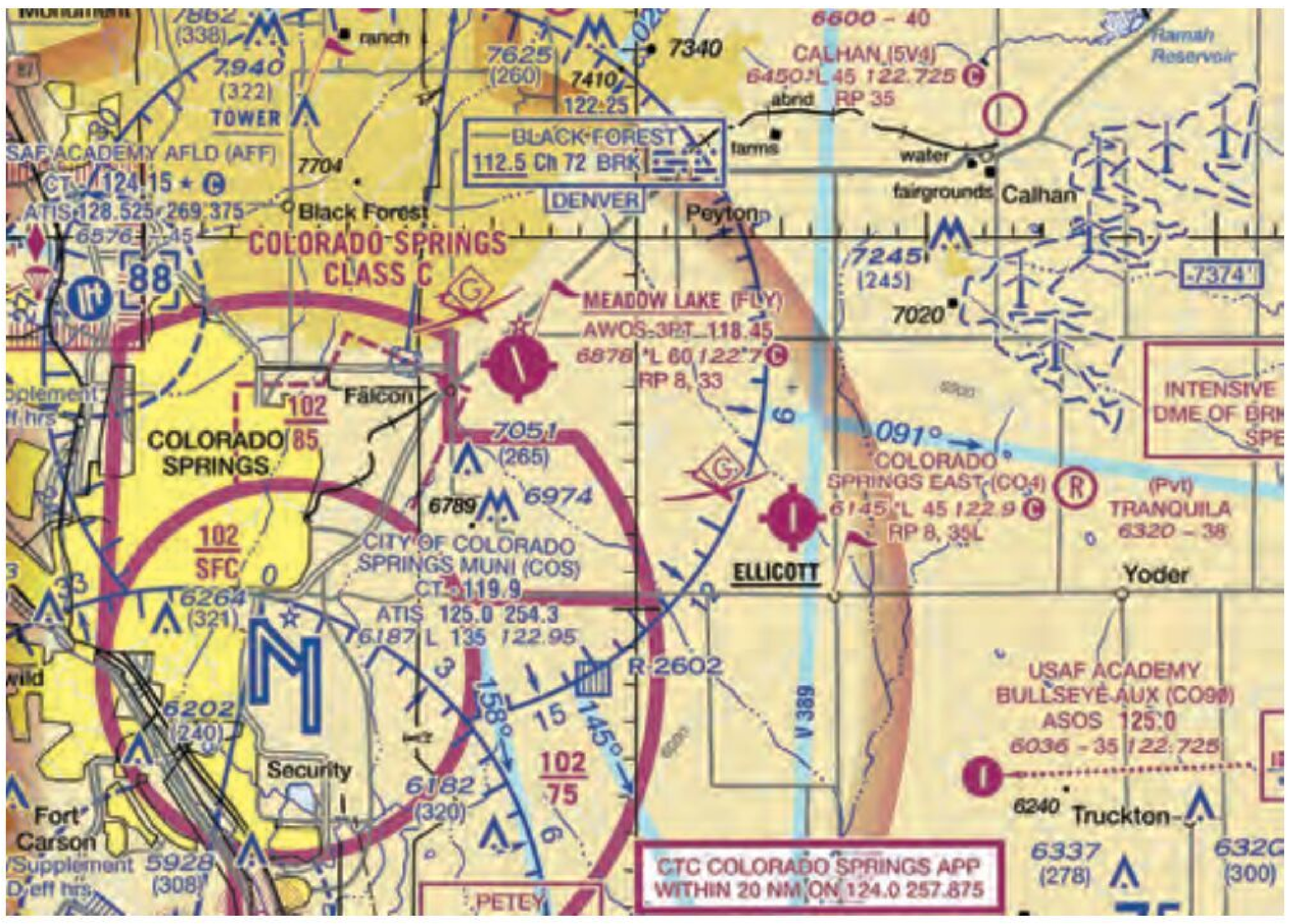
RADIO FREQUENCIES

Aviation communications take place using very high-frequency (VHF) waves similar to FM radio. Aviation uses the spectrum from 118 to 137 MHz, just above FM (which uses 88 to 108 MHz). Certain frequency arrangements are commonly used for specific purposes, though this can always vary. For example, frequencies from 121.60 to 121.90 MHZ are typically reserved for use on the ground at airports with a control tower (also referred to as "ground control"). Frequencies from 122.00 to 122.95 typically are used for weather discussions with Flight Service Stations (which pilots will call "radio"). One frequency pilots of every type should know is 121.50, which is reserved for emergencies (so you definitely want to avoid talking on this one).

To figure out what frequency or frequencies you may want to listen to, refer to your local aviation sectional chart (see the June/July and August/September issues of RotorDrone Pro for more information on how to read them). A great place to find your local map is on skyvector.com. Another place to look is the FAA's Airport/Facility Directory (AFD), though some knowledge on how to decipher its contents is required (on faa.gov, search "chart supplements"). The best place to start is to look for airports near where you are going to fly. Most portable radios have the ability to monitor several frequencies, continuously scanning through what you have set. Let's take a look at an example in the Colorado Springs area to see what I mean.

COLORADO SPRINGS EXAMPLE

Let's assume you're inspecting some wind turbines (those windmill symbols in the upper right corner of the sectional excerpt in Figure 1). There are a handful of public airports (private ones are those with "R" in a circle and usually aren't used much) in and around the area. Calhan airport is the closest, while Colorado Springs East is just over five miles away. Other proximate airports are Meadow Lake, USAF Academy Bullseye Auxiliary, and the largest, the City of Colorado Springs Municipal. Looking at these airports, note the number adjacent to the letter "C" within a shaded circle. For Calhan, this is 122.725, the MHz frequency for the common traffic advisory frequency (CTAF) for the airport. The CTAF is the frequency most commonly used by aircraft to broadcast their intentions at airports without a control tower (or when the tower is closed). Thus we'd want to program in the CTAFs for adjacent airports. Other frequencies we may want to include at the control tower (CT) at local airports, such as at Colorado Springs on 119.90 MHz. At big airports like Colorado Springs, there may be additional frequencies to handle inbound and outbound aircraft. In this case, note at the bottom of Figure 1 there is a white box with a frequency of 124.00 for Colorado Springs Approach Control. This might be one to add to one's radio for good measure.



The next tidbit of knowledge that is applicable to mention here is how aircraft normally operate in and around airports. Small planes that are arriving or departing an airport usually will fly higher than 1,000 feet above the ground when beyond a few miles from the field. If an aircraft is remaining nearby the airport, say to practice takeoffs and landings (which is referred to as "staying in the pattern"), they will operate at traffic pattern altitude, which usually is from 800 to 1,000 feet above the ground (the exact value can be found in the AFD). Larger aircraft will commonly stay high until coming in to land, only descending below 1,000 feet when within three or four miles of the airport. They will typically climb out rapidly after lifting off the runway. Long story short, unless you're operating right near an airport, you should not usually be anywhere near a manned aircraft as you'll most likely be below 400 feet above the ground anyway. Most likely, the only type of aircraft you may see that low is a helicopter. Unfortunately, most heliports are not marked on sectionals, and, among those that are, they do not always have frequencies associated with them and/or pilots rarely use them. Beware that you may also get the occasional helicopter coming or going from any type of airport.

Ok, so you have figured out what frequencies to listen to, but what is all the jargon being thrown around even mean? You will want to know how to decipher a few basic things when listening to pilots and controllers talk. Starting with the most basic is the phonetic alphabet. In order to avoid confusion about what letters radio users intend to convey, words are used instead of simply saying "B" or "C" because they could potentially be confused. The key to the phonetic alphabet can be found in the Aeronautical Information Manual Chapter 4-2-7 (available at faa.gov) and in the sidebar in this article.

Instead, you would use "Bravo" for "B" and "Charlie" for "C." Numbers are also presented in specific, unique ways. For example, the number nine is referred to instead as "niner" so to avoid confusion with the German word "nein," which means "no." Three is "tree" and five is "fife" again to avoid any ambiguity. Weird, yes, but true. Usually, numbers are stated individually. For instance, a pilot announcing intentions to land on runway 36 would say "three six" not "thirty six." But when announcing their altitude, pilots will use thousands and hundreds as descriptors, such as 1,500 being "one thousand, fife hundred" and 800 being "eight hundred."

Another thing to know is that aircraft have names, referred to as "call signs." For non-commercial aircraft, this will be their registration number, i.e., the numbers and letters you see printed on the side of the plane. Aircraft registered in the U.S. begin with the letter "N," which will be announced "November" while those from Canada are denoted by "Charlie" for "C." This first letter is then followed by a registration number or letter/number combination up to five characters long. One of my favorite airplanes growing up was N6115Q—"November six one one five Quebec." This is what we used to announce who we were and where we were going. Usually, the aircraft manufacturer is substituted for "November" for communications in the U.S. Also, once an aircraft has initially announced itself on frequency, its call sign is shortened for simplicity using the last three characters only. Thus N6115Q, a Cessna 152, becomes "Cessna one five Quebec."

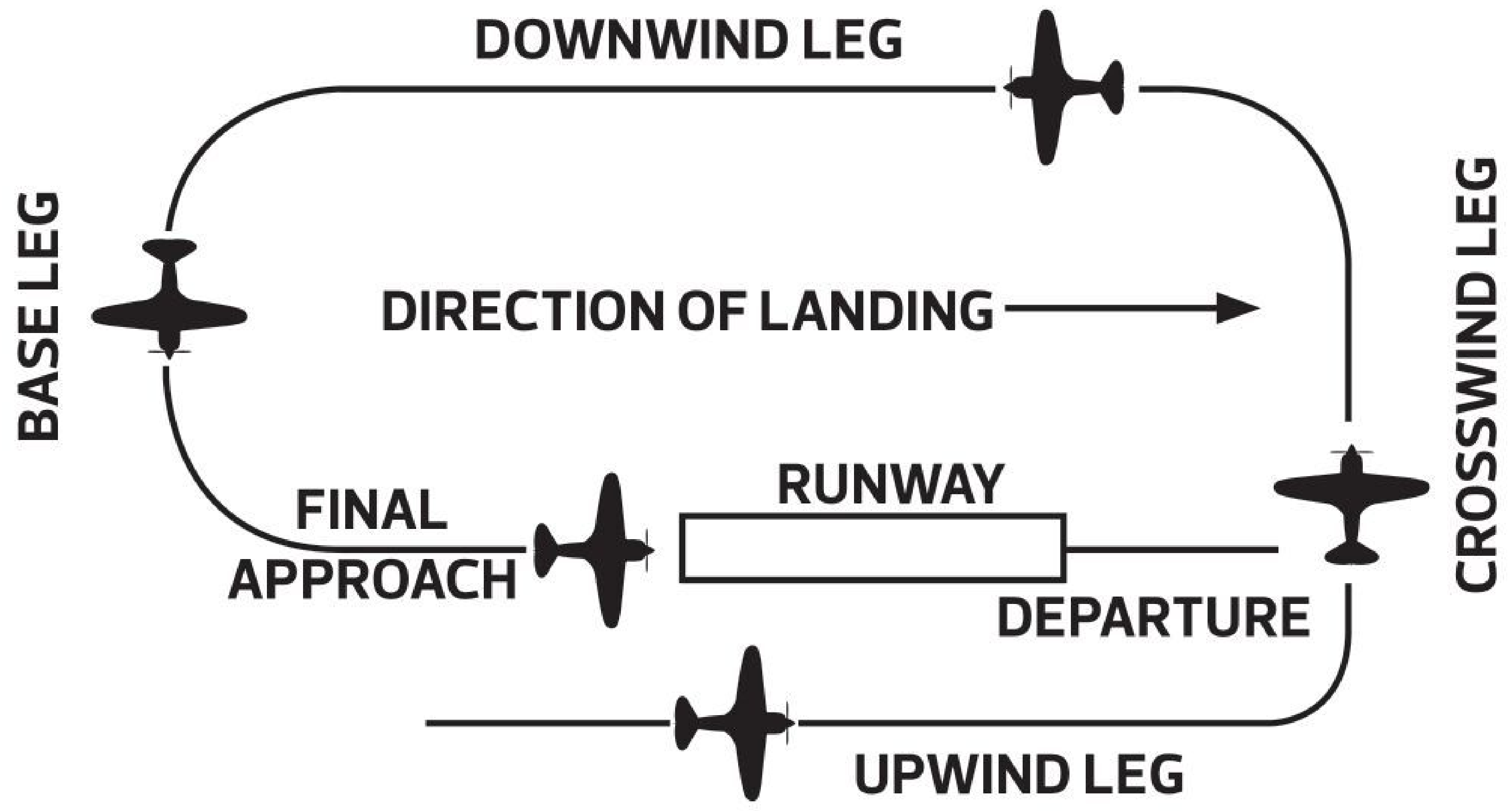
AIRPORT OPERATIONS

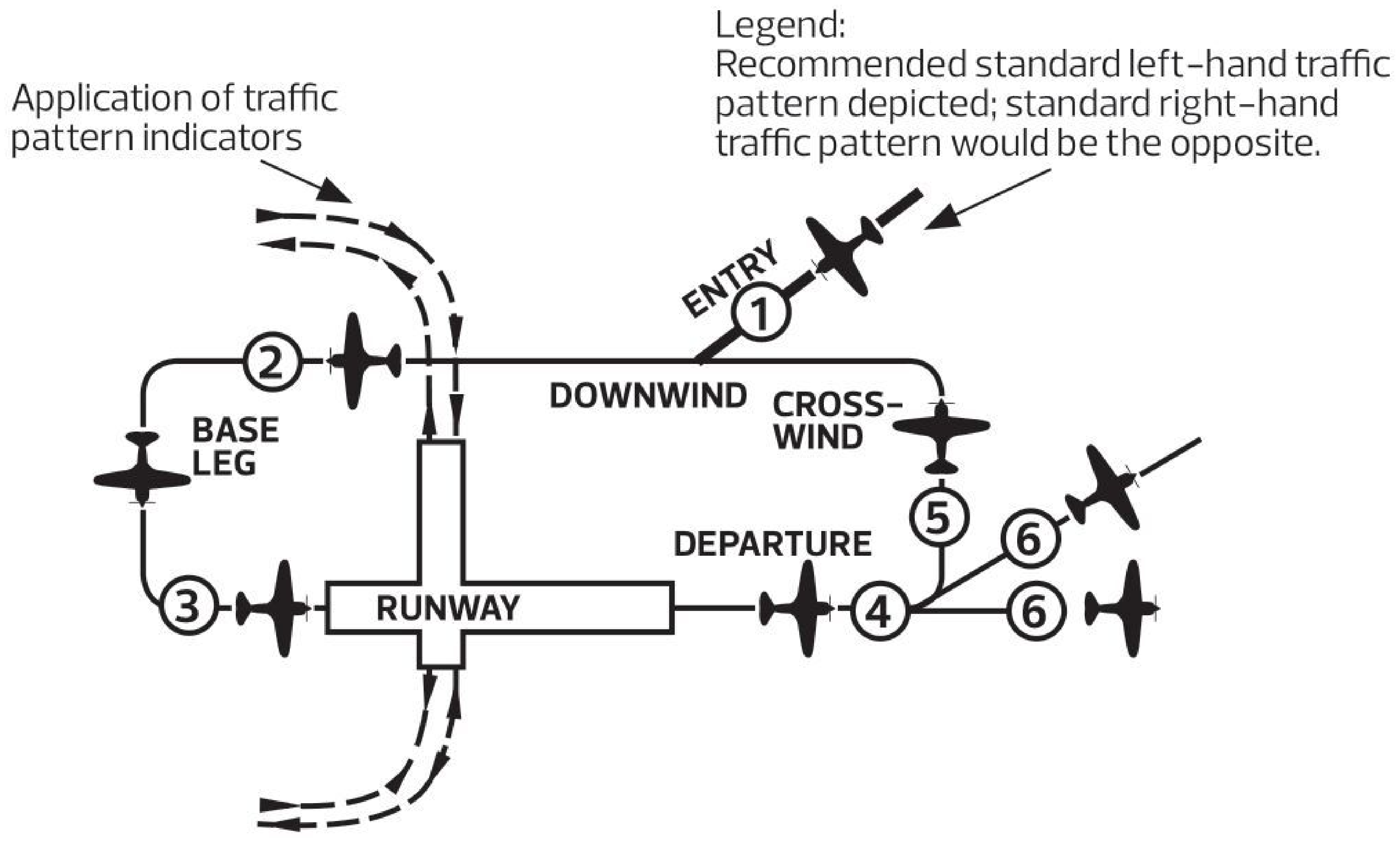
Now let's dive into how aircraft typically operate around airports. Aircraft approach airports to enter the "traffic pattern" so as to maneuver to align with the desired runway for landing. Pilots prefer to land into the wind; thus, they will normally pick the runway best facing into the wind direction. Runways are numbered based on the direction they are heading in relation to magnetic north (what would be read on a compass). For example, runway 36 is aligned with a 360 or due north heading, while runway 9 is aligned with east, or 090 degrees. Traffic patterns are divided up into five legs (see Figure 2). Departing aircraft fly the "upwind" leg, which is aligned with the departure end of the runway. The left perpendicular to the departure end is referred to as the "crosswind" leg. The leg parallel to and towards the landing end is called the "downwind" leg, because you're usually flying downwind on it. The leg perpendicular to the landing end of the runway is called "base," and when aligned with the runway for landing, aircraft are on "final approach." Traffic patterns are typically set up so that all turns are to the left, but in some cases, they are to the right, for example, to avoid buildings, reduce noise impacts, and so forth. Airports with right-hand traffic patterns will depict such on sectional charts by denoting "RP" and the runway number associated with the non-standard pattern. Looking back at Figure 1, Calhan airport uses a right turn traffic pattern for runway 35.

Aircraft are supposed to approach an airport at a 45-degree intercept to join the downwind leg at a point aligned with the runway's midpoint at traffic pattern altitude (see Figure 3). They will then turn downwind and

PHONETIC ALPHABET/MORSE CODE

Character	Morse Code	Telephony	Phonic (Pronunciation)
A	• –	Alfa	(AL-FAH)
B	– • • •	Bravo	(BRAH-VOH)
C	– • – •	Charlie	(CHAR-LEE) or (SHAR-LEE)
D	– • •	Delta	(DELL-TAH)
E	•	Echo	(ECK-OH)
F	• • – •	Foxtrot	(FOKS-TROT)
G	– – •	Golfa	(GOLF)
H	• • • •	Hotel	(HOH-TEL)
I	• •	India	(IN-DEE-AH)
J	• – – –	Juliett	(JEW-LEE-ETT)
K	– • –	Kilo	(KEY-LOH)
L	• – • •	Lima	(LEE-MAH)
M	– –	Mike	(MIKE)
N	– •	November	(NO-VEM-BER)
O	– – –	Oscar	(OSS-CAH)
P	• – – •	Papa	(PAH-PAH)
Q	– – • –	Quebec	(KEH-BECK)
R	• – •	Romeo	(ROW-ME-OH)
S	• • •	Sierra	(SEE-AIR-RAH)
T	–	Tango	(TANG-GO)
U	• • –	Uniform	(YOU-NEE-FORM) or (OO-NEE-FORM)
V	• • • –	Victor	(VIK-TAH)
W	• – –	Whiskey	(WISS-KEY)
X	– • • –	Xray	(ECKS-RAY)
Y	– • – –	Yankee	(YANG-KEY)
Z	– – • •	Zulu	(ZOO-LOO)
1	• – – – –	One	(WUN)
2	• • – – –	Two	(TOO)
3	• • • – –	Three	(TREE)
4	• • • • –	Four	(FOW-ER)
5	• • • • •	Five	(FIFE)
6	– • • • •	Six	(SIX)
7	– – • • •	Seven	(SEV-EN)
8	– – – • •	Eight	(AIT)
9	– – – – •	Nine	(NIN-ER)
0	– – – – –	Zero	(ZEE-RO)




Legend:
Recommended standard left-hand traffic pattern depicted; standard right-hand traffic pattern would be the opposite.
Application of traffic pattern indicators
ENTRY
1
2
DOWNWIND
CROSS-WIND
BASE LEG
5
6
DEPARTURE
3
RUNWAY
4
6

continue in the pattern for landing, only descending from pattern altitude when approximately abeam the landing end of the runway. They will typically only get down to 400 feet or below when within about a mile of the runway end. Aircraft will ordinarily be at 200 feet at a point approximately half a mile from the runway. Departing aircraft have more options open to them: they will depart the traffic pattern straight out (upwind), at a 45-degree angle between upwind and crosswind, or even heading downwind. Do note that pilots can do whatever they want at airports with no control tower, so they may be creative in arriving or departing the area. For airports with control towers, air traffic control will dictate how pilots maneuver in the vicinity.

Some other helpful things you might hear on aviation radio frequencies are information about aircraft position and weather conditions. At airports without control towers, pilots will often report as they approach or depart an airport in terms of the direction they are from the airport and how far and what they intend to do next. When there is a control tower, things will be much more organized, with detailed position and distance information being the norm. Weather details, such as wind, temperature, barometric pressure, visibility, cloud heights, and cloud cover, are commonly discussed. Weather and other airport information is also available through an automated recording at busier airports on ATIS (Automatic Terminal Information Service) frequency, which is marked as such on sectional charts. A few things to keep in mind: wind is reported in terms of the direction it is blowing from, and its strength is noted in knots (nautical miles per hour). Thus winds reported as "two two zero at one four" means the wind is blowing from 220 degrees (out of the south-southwest) at 14 knots. Temperature is in Celsius, barometric pressure in inches of mercury, visibility in statute miles, cloud heights in feet, and cloud cover is described as scattered, broken, overcast, obscured, or clear.

AN OVERVIEW

Let's now put it all together for some practical use with an example of what you might hear if eavesdropping on aircraft in the local area, as shown in Figure 1. Tuning into Calhan's frequency of 122.725, we hear an aircraft call "Calhan Traffic, Piper one eight four one lima, entering a forty-five-degree entry for runway one seven, descending out of eight thousand, Calhan Traffic" (note: pilots often use nonstandard language, so let commonsense fill in the blanks as necessary). Where might this airplane be, and could it be a factor if we are currently inspecting the wind turbines? If you recall, unless otherwise noted, traffic patterns are made with turns to the left and runway 17 faces towards the south (170 degrees magnetic); therefore, an aircraft entering a 45-degree entry for the downwind leg would be east of the airport/runway, allowing for left turns to base and final approach. You will likely see the aircraft because it will be passing close to your position, depending on which turbine(s) you are currently inspecting and because the turbines have an elevation of around 7,374 feet (as noted to the right of the symbols on the sectional), the airplane's altitude may be getting close to where you might be operating.

While this was a quick overview of aviation lingo and how to tune it in, the best way to learn about aviation speak is to listen regularly to air traffic communications. A great way to do this without a radio is via liveatc.net. You can ramp up your aviation communications knowledge immensely by tuning in along with your Chapter 4 of the AIM. Coupling this with visual observation or flight tracking apps/websites, you can learn a lot about how aircraft move in local areas, in and around airports, and so forth, along with how all of this is (or is not) communicated to air traffic control and other aircraft. By doing all of these recommendations while not operating your drone, you can be best prepared to use aviation radio transmissions for situational awareness when you do, in fact, have your drone in the air.

ABOUT THE AUTHOR

Dr. David Ison is a professor in the Graduate School at Northcentral University, where he teaches research methods and statistics to doctoral students. Previously, he served as a commercial airline pilot. He has published two books on drones, "The Complete Remote Pilot" and "Small Unmanned Aircraft Systems Guide: Exploring Designs, Operations, Regulations, and Economics."

The presumed conflict between crewed and uncrewed aircraft is nowhere to be seen at Eastern Oregon Regional Airport, where the two operate side-by-side in controlled airspace through careful coordination with the control tower.

DRONE ON THE RANGE

Flying at a UAS test site

By Patrick Sherman

At most airports, if you walk out onto the tarmac carrying a drone, about the best you can hope for is to be asked, "What do you think you're doing here?" At Eastern Oregon Regional Airport, however, they ask a different question, "How can we help?"

That's because Eastern Oregon Regional Airport (PDT) is home to the Pendleton Unmanned Aircraft Systems (UAS) Range—and drones are their business.

"When people come out to do testing with us, they find that our control tower is very familiar with UAS," said Darryl Abling, the range manager. "They have a lot of experience coordinating multiple, simultaneous UAS operations alongside our manned traffic—commuter airplanes, general aviation pilots, crop dusters, cargo flights, helicopters and the military."

While the full integration of UAS into the National Airspace System (NAS) may still be years away elsewhere, it's happening right now in Pendleton. Along with my Embry-Riddle colleagues, I had the chance to see it for myself over this past summer.

STRETCHING OUR WINGS

To better prepare our students for a future where UAS will be a mainstay in the aviation industry, the Embry-Riddle Worldwide Campus Department of Flight recently acquired a fleet of new drones—and not the sort that would fit easily inside a shoebox, or even a compact car.

These are big, heavy, sophisticated aircraft, including the DJI Agras MG-1P, a crop-dusting drone with a maximum takeoff weight of 54.7 pounds; the Lynx VTOL from SRP, originally developed for U.S. special forces; and, the Applied Aeronautics Albatross, a fixed-wing platform with four-hour endurance capable of accommodating modular payloads.

The only problem with big, heavy, sophisticated drones is that you need plenty of open space, as well as on-site resources—like a paved runway, water, power and the Internet—to test them. That was what brought us to Pendleton: the test range had everything we needed, and a whole lot more.

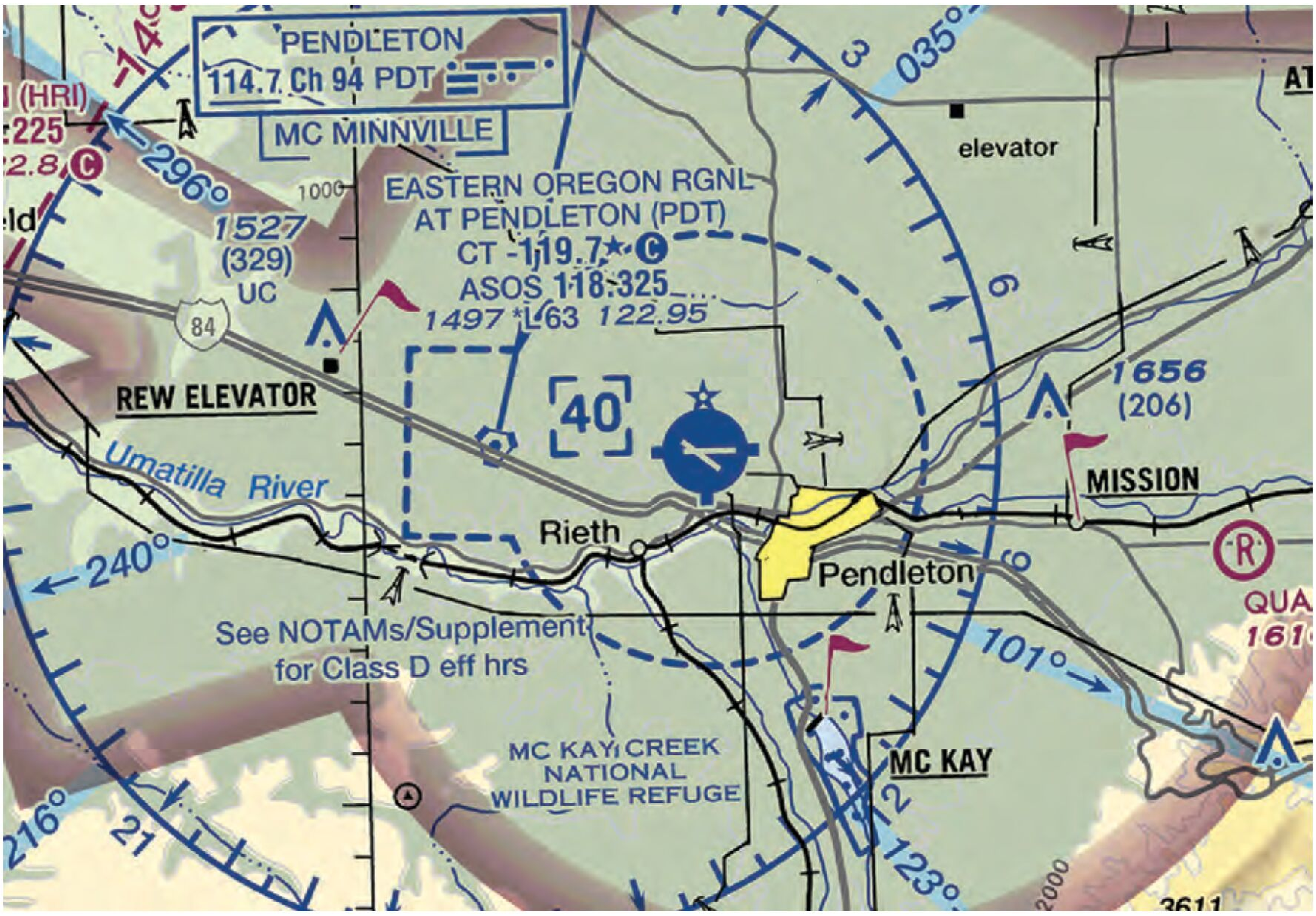
The range encompasses 14,000 square miles, and airspace is available from the surface up to 15,000 feet. It encompasses a wide range of terrain, including farmland, vineyards, orchards, forests and mountains. With an average of 347 days of visual flight rules (VFR) weather each year, it's always a good day to go flying in Pendleton.

Our operations would be confined to the airport property, which itself required a big mental shift as a drone pilot. PDT is located in Class D airspace, and while there is a Low-Altitude Authorization and Notification Capability (LAANC) grid to allow for UAS operations in the vicinity, the squares at the airport itself have an altitude of "zero," as you would expect.

However, in order to fly there, we didn't go to the DroneZone on the FAA website and make our case 90 days in advance. Instead, we picked up a hand-held aviation radio, tuned it to the

FAA
Licensed

Members of the Embry-Riddle Aeronautical University Worldwide Campus Department of Flight control the movement of small UAS overhead from a makeshift mission control center set up alongside taxiway Foxtrot at Eastern Oregon Regional Airport.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Eastern Oregon Regional Airport (PDT) is encircled by Class D controlled airspace, to an altitude of 4,000 feet MSL.

Pendleton tower frequency at 119.7 MHz and stated our intentions. Given that the FAA generally prohibits drone pilots from communicating on aviation frequencies, this was a very strange feeling indeed.

For the most part, the syntax was identical to what crewed aircraft pilots use, with one exception: Rather than using the absurdly long registration numbers the FAA assigns to drones to identify our aircraft, we adopted call signs. Regardless of its type or specifications, the first aircraft we launched became "Riddle 1." If we launched another platform while the first one was still active, it was designated "Riddle 2."

The following day, the aircraft that had been known as "Riddle 2" would become "Riddle 1" if we launched it first. If we were only operating one aircraft at a time, each of them would be referred to as "Riddle 1" in turn. Because we were flying rotorcraft, VTOLs and fixed-wing platforms, we also had to state at the outset what type of aircraft it was, so the tower knew what type of behavior to expect: hovering and slow maneuvers or continuous forward flight.

STARTING SMALL

Today, the Pendleton test range is thriving, with 150 people working full time for various clients—most of whom are shielded by non-disclosure agreements—making it a key economic driver for the city. However, it had not always been that way. Not so very long ago, the airport was viewed as a drain on the city's resources.

"I moved out here to work nine years ago," said Steve Chrisman. "At that time, the city manager told me, 'We can't afford to have an economic development director and an airport manager, so you'll have to do both.' I didn't know anything about aviation at the time, but I do know how to recognize an underperforming asset when I see it."

Among the people Chrisman met was the commander of an Army National Guard unit based at the airport, which operates RQ-7 Shadow reconnaissance drones.

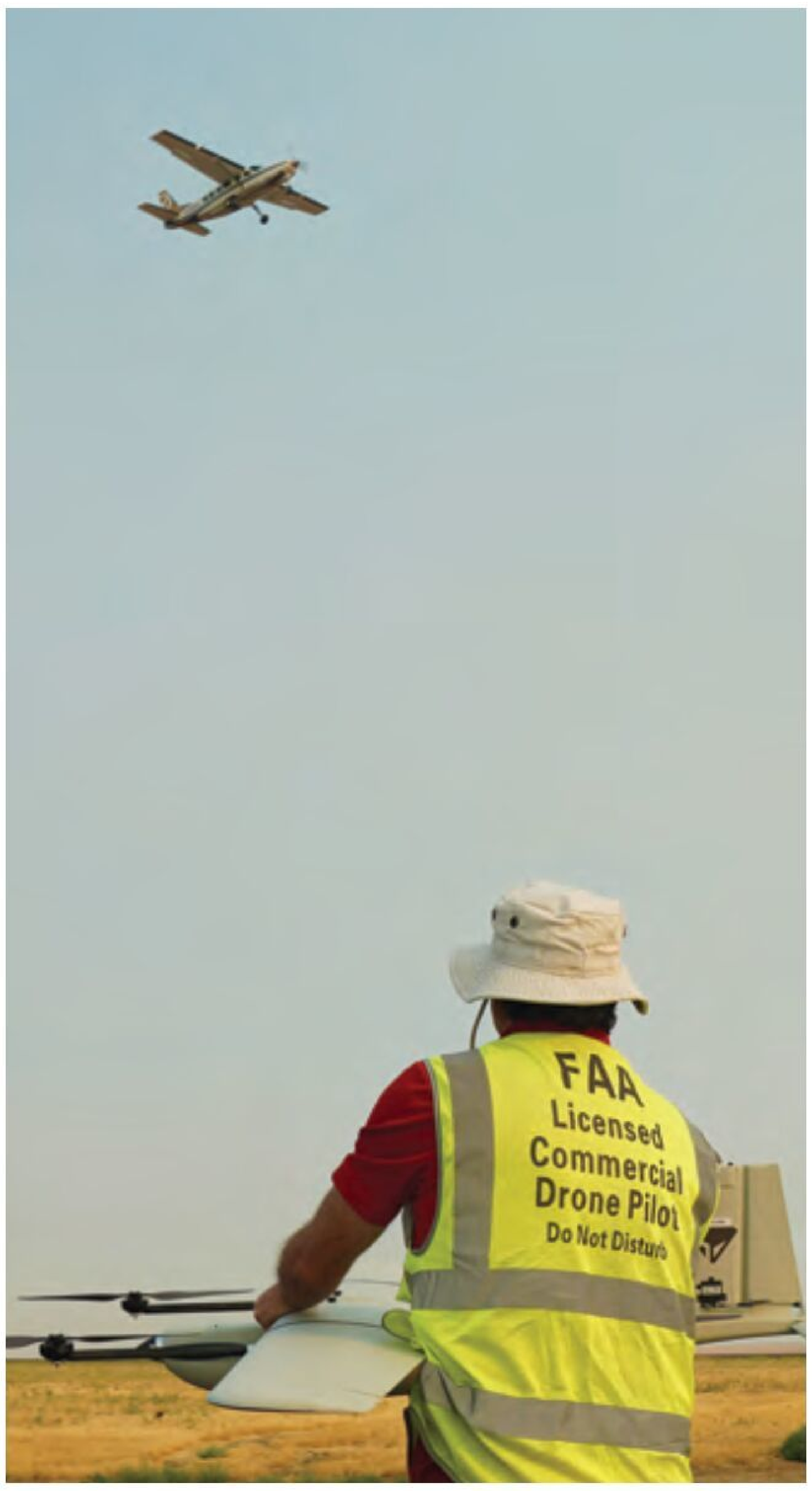
"He was in the process of securing permission to operate his Shadows at the airport, so the unit didn't have to travel to the restricted airspace at Boardman in order to fly," Chrisman recalled. "He said to me, 'Look, civilian drones are about to become a big thing, and the airport would be a great place to test them.'"

Investigating further, Chrisman discovered that the FAA had put forward a proposal to establish UAS test ranges at different locations around the country, and he began to explore how Pendleton could become one of them. Ultimately, he linked up with sites located in Alaska and Hawaii to become part of what is today the Pan-Pacific Test Range Complex.

"For the first couple of years, there was very little activity at the range," said Abling, who became the full-time range manager once its operations started to expand. "One of our early clients was Pacific Northwest National Laboratory. They did a lot of training with the Arctic Shark out here. It's a 600-pound, fixed-wing platform used to study the atmosphere at high altitude. We also

EASTERN OREGON REGIONAL AIRPORT
UNLOADING
LOADING
ONLY

Eastern Oregon Regional Airport—identified as PDT on aeronautical charts—has flourished since it began hosting the Pendleton UAS Range beginning in 2013. About 150 people work full-time at the airport for its various clients, developing and testing new drone aircraft.



A light airplane departs Eastern Oregon Regional Airport while a member of the Embry-Riddle Worldwide Campus Department of Flight prepares to launch a UAS in the foreground.

had Yamaha doing some work with their R-Max helicopters."

Then, after two years of struggle, the dam broke: Airbus subsidiary A^3 selected Pendleton to prototype and test its Vahana urban air mobility platform.

"They came here and made Pendleton their home," said Chrisman. "They took over this big hangar and had people working here full time. Those are good-paying, aerospace jobs—something that any rural community would be excited to attract."

Following Vahana's success, interest in the range began to grow, according to Abling. "Ultimately, the UAS industry is still a small community," he said. "Everyone has relationships with everyone else, even if they change companies, and so pretty quickly the word got around that Pendleton was a great place to do your testing."

RADIO TRAFFIC

"Pendleton tower, this is Riddle 1, requesting clearance for takeoff from taxiway Foxtrot," I said into the radio clipped to my vest.

"Roger that, Riddle 1, this is Pendleton tower. Does Riddle 1 need to roll, or does it go straight up?" came the reply.

My cheeks flushed—I had forgotten to specify what type of aircraft we were flying.

"Pendleton tower, Riddle 1. We're flying a VTOL. It will make a direct ascent to 150 feet AGL and then transition to forward flight southeast of taxiway Foxtrot," I replied, trying not to sound flustered.

"Riddle 1, Pendleton tower: you are cleared for takeoff, altimeter two-niner-niner-seven," the voice came across the radio, unperturbed.

"Riddle 1," I said, acknowledging the clearance.

One of my colleagues pressed the "Launch" button on his laptop, and the Lynx leapt into the air and ascended briskly before its main motor powered up and pushed it silently out over the wheat fields to the south. Another mission had begun, more or less successfully.

Our base of operations on the airport grounds was a gravel pad with water and electrical hook-ups, built specifically to support UAS operations—one of five along the south edge of taxiway Foxtrot, which served as our "runway" for the duration of our stay in Pendleton. However, it was a resource that we had to share. Occasionally the tower would call to let us know that a small jet or a turboprop was departing on Runway 25, and we needed to make the taxiway available for them.

For all of the drama around the supposed conflict between crewed and uncrewed aircraft, it was a remarkably seamless process. We were all aviators, each of us placing our full confidence and trust in one another as professionals, dedicated first and foremost to the safety of flight. Our operations comprised just a tiny fraction of the overall UAS activity at the range, according to Abling.

"We broke 1,000 operations per month for the first time in May," he said. "Somewhere between 600 and 1,000 operations per month has been pretty typical lately. However, based on our scheduling and what our customers are telling us, we're expecting that to go up to between 2,000 and 2,500 operations per month next year."

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After hosting numerous UAS test campaigns at the Eastern Oregon Regional Airport, range manager Darryl Abling has accumulated a substantial collection of challenge coins, laid out on his desk for visitors to admire.

PENDLETON ROUND-UP
SEPT 15-18, 2021

Pendleton's annual rodeo, known as the "Pendleton Round-Up," is held in an outdoor arena of the same name the second week of September each year. The arena lies in a valley, just below the city's airport, which is also the home base for the Pendleton UAS Range.

Pendleton
An Airport with a Future, and a Past

Fifty years hence, history may look back and note that Pendleton played an important role in the development of uncrewed aircraft systems (UAS), leading to their full integration into the National Airspace System (NAS) and the aviation industry. However, this high-desert airfield has already secured a place for itself in posterity.

Initially constructed as a small municipal airport, the likelihood that the United States would enter World War II prompted its expansion in early 1941. Over six months, the Army Corps of Engineers added two runways as well as facilities for 2,500 personnel. In June, the 17th Bombardment Group of the Army Air Corps was transferred to Pendleton.

Seven months later, the Japanese launched a surprise attack on Pearl Harbor, and the U.S. entered World War II. With enemy submarines marauding off the coast of Oregon and Washington, sinking merchant ships and shelling coastal defense batteries, the 17th was assigned to anti-submarine patrol.

A B-25 Mitchell medium bomber—the type of aircraft used by the Doolittle Raiders during their famous attack on Tokyo in 1942—is displayed at the Army National Guard base at Eastern Oregon Regional Airport, to commemorate its role in the daring mission.

In 1942, volunteers from the unit joined Lt. Col. James Doolittle to conduct a daring raid on the Japanese home islands, in retaliation for the attack on Pearl Harbor. Launching from the aircraft carrier Hornet on a one-way trip, the Doolittle Raiders bombed Tokyo and several other Japanese cities before bailing out over war-torn China. Of the 80 men who participated in the attack, three were killed in action, and eight were captured by the Japanese—but 69 of them were smuggled back to friendly territory by Chinese forces and returned to active duty.

Pendleton Army Air Field was further distinguished during the war as the home base of the 555th Parachute Infantry Battalion. The unit, comprised entirely of African American soldiers, was tasked with a dangerous mission that remained a closely held secret until the end of the war. In an effort to cripple industrial production in the U.S., the Japanese launched incendiary "balloon bombs" across the Pacific, in the hopes of setting the forests or Oregon and Washington ablaze.

The men of the 555th—known as the "Triple Nickles"—would parachute in to the remote locations where these bombs fell and extinguish the fires before they could spread. They were the first "smoke jumpers," and the elite firefighters who fill that role today recognize and honor the 555th as their spiritual forebearers.

The 555th Parachute Infantry Battalion prepares for deployment as the nation's first "smoke jumpers," formed in secret to counter the threat posed by incendiary Japanese "balloon bombs" to the forests of the Pacific Northwest. Image courtesy the U.S. Forest Service.

FAST MOVER

According to Abling, a key to the range's success is its ability to "move at the speed of business."

He explained, "I think it's the ability to come in and start flying almost immediately that makes us attractive to prospective customers. When somebody contacts us about flying at the range, we respond with two documents: a mission-requirements template and an expedited-project questionnaire."

The first seeks to understand what the prospective client hopes to achieve and what resources they require. That includes airspace, supporting infrastructure, office or hangar space, a mobile mission control center or even a remote site off the airport.

"With that, we are able to give them a rough order of magnitude for pricing," he said. "It helps that our pricing is very competitive compared to government ranges. They can come here and fly without spending a boatload of money on the range itself."

The expedited project questionnaire asks about the aircraft the client intends to test: What frequencies does it use for control and telemetry? What is its lost-link behavior? How fast does it go? What is its maximum speed and altitude?

"We've never had to say 'No' to anybody based on what they tell us, but we need to understand those things," said Abling. "If the aircraft is under 55 pounds, it is immediately covered under our blanket Certificate of Authorization (COA) from the FAA. Then the University of Alaska, which heads the Pan-Pacific Range, writes up an airworthiness statement that allows the vehicle to be tested on the range.

"If it weighs more than 55 pounds, it has to be specifically listed on our COA," Abling said. "We have a lot of different aircraft types that are already on that list, but if this is a new one, it requires a paper-and-ink change to the COA, and that takes between two and three weeks, depending on how busy the FAA is.

"The upshot is: If you're small, we can get you flying in two or three days; if you're big, it's going to take a couple of weeks."

The surge of business at the range has led to a building boom at the airport. Work was recently completed on 30,000 square feet of new hangar space. On the north side of the field, flanking a runway dedicated exclusively to UAS, a 150-acre industrial park is now ready for new tenants, with water, power and high-speed-data connections available on site.

"Right now, we're in the process of building a hotel here on the airport property, right across the parking lot from the terminal building," said Abling. "It's going to be a 72-room Radisson, and when that opens in the first quarter of 2022, it's going to make the range even more attractive. People will be able to fly in from Portland on Boutique Air, check into the hotel, which will have its own restaurant and bar, and then walk out onto the field to do their testing."

A pair of Yamaha Fazers—the latest iteration of the company's long-serving crop-dusting R-MAX UAS—are stored in a hangar that housed the planes used by the Doolittle Raiders during World War II.

WELCOME TO
PENDLETON AIRPORT
& Industrial Area

Eastern Oregon Regional Airport laid fallow for decades following the aviation deregulation in the 1980s, but recent years have seen a burst of new construction as it has emerged as a hotbed for UAS testing. Here, the groundwork is being laid for a new 72-room Radisson hotel, set to open in the first quarter of 2022.

LET 'ER BUCK

Even apart from the airport—with its storied past and bright future—Pendleton is a town that punches well above its weight in terms of its history and culture. Incorporated on Oct. 25, 1880, with 730 inhabitants, among the town's first major industries was a scouring mill, where wool from local sheep herds was washed and cleaned before being shipped out by rail.

The operation expanded into a full-service woolen mill in 1895, weaving blankets and robes for the Native American tribes in the region. Today, the Pendleton Woolen Mill brand is known worldwide for its quality wool apparel—and every item sold still includes a label telling the customer that it is "Warranted to be a Pendleton."

In 1910, Roy Raley, a local attorney with a showman's flair and a keen mind for business, established a rodeo

The Lynx VTOL from SRP ascends vertically for a test flight above Eastern Oregon Regional Airport, where crewed and uncrewed operations have been seamlessly integrated as part of the Pendleton UAS Range.

the second week in September. The tradition continues to this day as the world-famous Pendleton Round-Up, which brings in visitors from all over the world and has been voted America's best outdoor rodeo for the past five years.

The town's Old West spirit is still very much alive today, as I discovered along with my Embry-Riddle colleagues, exploring the town after a long, hot day on the tarmac. Life-sized statues of the many colorful characters who have shaped the town through the years dot the sidewalks, and the restaurants and bars pay homage to the town's frontier history.

It's an attitude that even extends to the UAS range, according to Chrisman, who became the town's full-time economic development director once the range was well established. "Pendleton is still a handshake kind of town," he said. "That 'git 'er done' attitude still prevails here."

That was certainly our experience. During our visit, the Albatross went awry when we attempted an autonomous take-off, tearing a jagged chunk out of the its propeller when it careened off the runway. Remember, we were there to test these aircraft—and testing necessarily involves the possibility of failure.

The following day, we got to talking with another UAS crew operating at the range. We discovered that they also had an Albatross in their fleet, and they volunteered a spare propeller to get us back up and flying, along with some helpful advice.

That was one tiny example of what economists call the "cluster effect." When a certain type of business is established in a geographic area, it becomes easier for similar businesses to get started and grow in that same area. That's why automobile production was concentrated in Detroit for the first half of the 20th century, or why so many tech firms are based in the San Francisco Bay Area.

Of course, that raises the question of how a business cluster gets started in the first place. Economists are divided on the subject, but Chrisman seems to think it could have something to do with pure, old-fashioned frontier stubbornness—at least in the case of Pendleton.

"There have been some bumpy spots along the road," he said. "But the City Council has been absolutely supportive of the range from its inception, even before there was a lot of activity. They moved forward on faith, and that has absolutely paid off."

Patrick Sherman is a full-time UAS instructor at the Embry-Riddle Aeronautical University Worldwide Campus Department of Flight.

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WHEN DRONES GO BAD

THE YEAR IN REVIEW

By Patrick Sherman

Unfortunately, not everyone who comes up with a new use for drones has the betterment of humanity—or even legal profits—as their top priority. Criminals and terrorists can be innovators, too. In this final report for 2021, through *RotorDrone Pro's* partnership with DroneSec, we are going to take a step back from reviewing individual instances when drones go bad and instead look at the new trends that have emerged over the past year.

DECEPTION

Canaries. First among these is the use of small drones as canaries, not as robotic replacements for domesticated songbirds, but rather in the sense of being "a canary in a coal mine." Until the mid-1980s, it was common practice for miners to bring a canary with them underground. Being more sensitive than humans to the buildup of deadly carbon monoxide gas, the bird's abrupt silence was a signal to the miners that they needed to evacuate immediately.

The drones flown as canaries today serve a similar function: The would-be aerial trespasser sends out a small, cheap drone ahead of a larger aircraft, which will carry contraband. Its mission is to test for the presence counter-uncrewed aircraft systems (C-UAS) defenses. If the small drone is jammed, intercepted or exhibits strange behavior, the operator knows not to launch the larger aircraft.

The use of a canary offers another benefit, as well: Someone flying a drone over a restricted area is guilty of a much less serious offense than if the drone is carrying drugs or weapons, for example.

In the instances DroneSec has studied, canary drones have been launched anywhere between 10 minutes to 24 hours before the larger aircraft is deployed. This creates a dilemma for the security staff at these restricted facilities. If a small drone appears, should C-UAS assets be deployed immediately to disable it, or should they be kept in reserve in case a larger aircraft carrying contraband appears later?

A variation on the canary strategy is "the swarm." This approach relies on a number of individual drones operating simultaneously over a restricted facility, in an effort to overwhelm and confuse the security staff. This could be a "true" drone swarm, where a single operator, or a small team, control a much larger

A small drone may not be able to deliver a substantial payload inside the perimeter fence of a secure facility, like a prison or jail, but it could actually be a "canary"—probing for C-UAS defenses before a larger drone brings in a load of contraband.

group of aircraft—like the aerial light shows choreographed by Intel — or it could simply be multiple pilots, each flying one drone.

In a report compiled by the United States Bureau of Prisons, corrections officers reported observing 15 individual aircraft during one single swarm incursion. A subsequent investigation revealed that only one of them was actually carrying contraband. The other aircraft were present simply to provide a distraction.

Camouflage. Illicit operators are also choosing simple but proven approaches to conceal their activities, such as camouflage. As an example, DroneSec has noticed an uptick in the number of drones being recovered from criminal operations that are equipped with low-noise propellers. These can reduce rotor noise output by up to 60 percent.

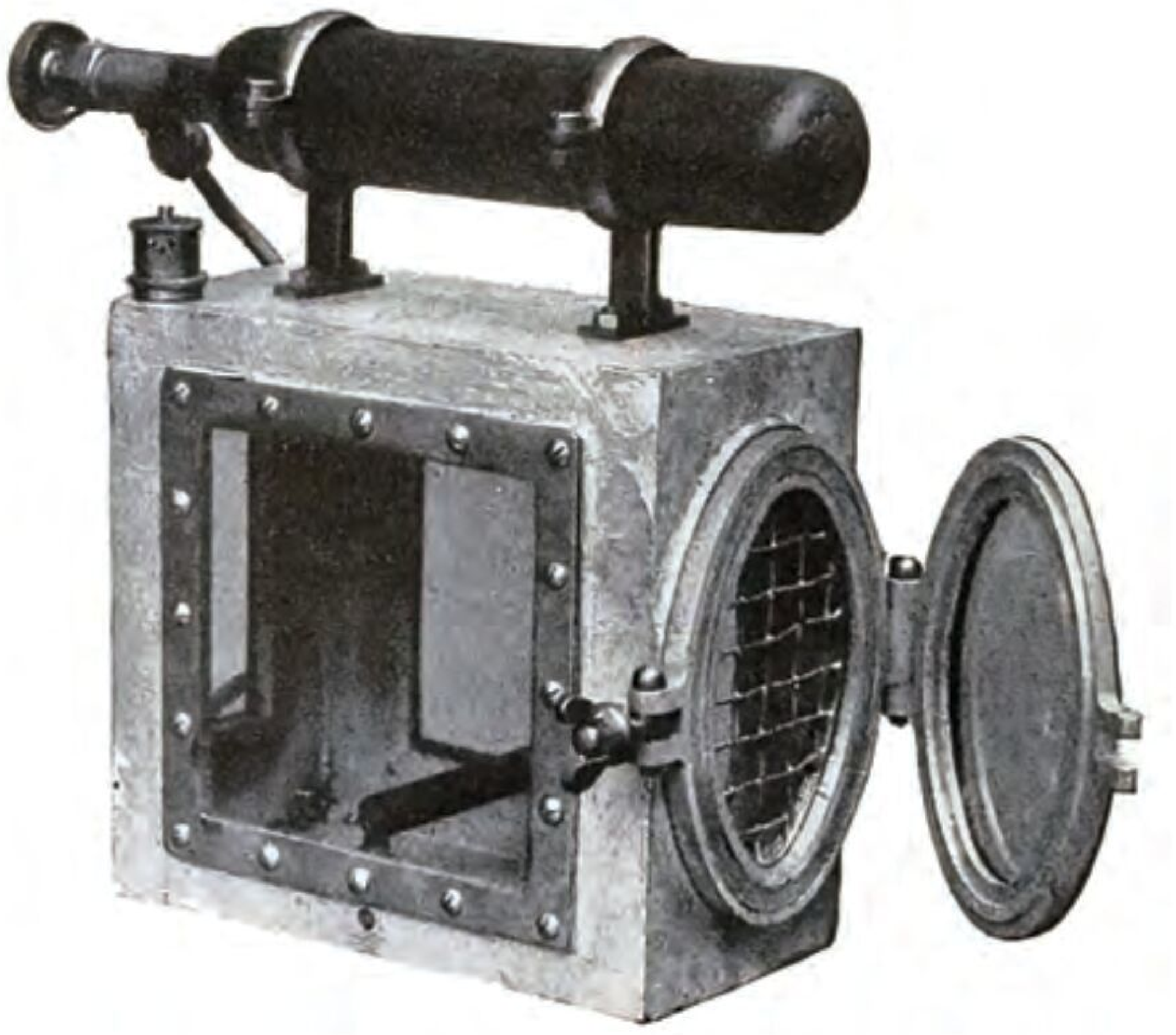
In its own "Red Team" testing, DroneSec deployed low-noise propellers while attempting to fly a discrete mission. They found that while they do not render the aircraft silent, they could reduce the likelihood of detection in certain environments.

Another approach is to modify the aircraft's exterior, to reduce the likelihood that it will be visually observed. For C-UAS hardware that relies on optical recognition for target identification, simply changing the drone's visible shape or silhouette could be sufficient to fool these systems.

Also, along the U.S.-Mexico border, there has been an increase in the number of recovered drones used by drug smugglers that are painted light blue, in an effort to blend in with the sky on a sunny day. Often, these same aircraft have their LED lights either covered with tape or removed outright, again to make them less visible.

An alternative is to make drones as conspicuous as possible, in order to draw the attention of law enforcement or security forces away from an actual threat. That appears to have been the case late last year when Maoist rebels in central India flew drones around the police station in Gadchiroli, raising fears of an attack.

"The latest drone sightings may be linked to the Maoist strategy of keeping security forces distracted or engaged at their own posts to facilitate passage of their leaders," said an unnamed government source, quoted in the Times of India.



Miners used cages like this one to bring canaries into the depths of coal mines, to provide an early warning about the build-up of deadly carbon-monoxide gas. Note that the handle is also an oxygen cylinder that was used to resuscitate the bird.

DRONE TEAM
DRONE TEAM

Intel uses a swarm of thousands of illuminated drones, all operated from a single-user interface, to create stirring images in the night sky for global events such as the Olympic Games. Much smaller swarms have been used in an effort to overwhelm security staff at restricted sites, such as prisons.

In Guatemala, drug smugglers used drones to illuminate a temporary landing strip deep in the jungle, allowing a small jet to land carrying almost 4,000 pounds of cocaine.

ILLICIT LOGISTICS

Contraband Delivery. Amazon and its erstwhile competitors are not the only ones who believe in drones' potential to deliver products for hard-to-reach customers. The delivery of contraband—to include cell phones, tobacco, drugs and weapons—to incarcerated persons is among the most frequently reported type of malicious drone operation.

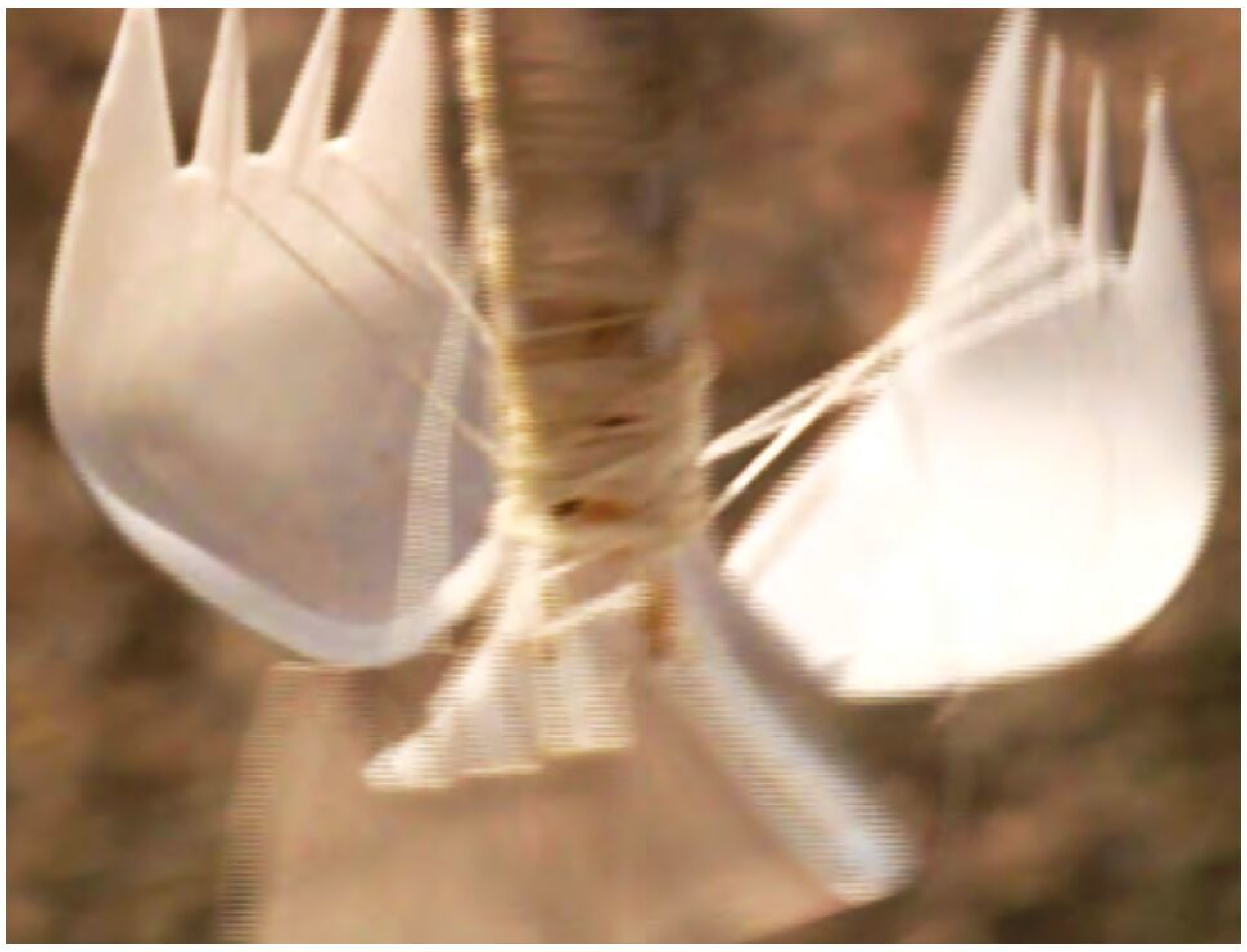
By analyzing numerous incidents over the past several years, DroneSec has identified certain common items and equipment found in the possession of those attempting to smuggle contraband into prisons using drones. These include:

- Extra batteries or battery extensions for longer flight time;
- Antenna range extensions;
- Drop mechanisms;
- String for suspending the payload below the aircraft;
- Black plastic bags to reduce the visibility of contraband at night; and
- Black tape used to cover the aircraft's navigation lights.

In one unique case out of Guatemala, drones were used to facilitate the delivery of nearly 4,000 pounds of cocaine but not by carrying it. Instead, they were fitted with lights and served to illuminate a primitive airstrip cut deep in the rain forest, allowing a conventional airplane packed with drugs to land.

Looking ahead, corrections officials are concerned that a sufficiently powerful drone could be used to extract a prisoner directly from the exercise yard to freedom. While that may once have seemed far-fetched, the rapid progress being made toward the development of single-seat, all-electric urban air mobility (UAM) platforms has already proven the feasibility of the concept.

There is even a precedent: In 2006, 2009 and 2013, several prisoners—including a convicted murderer—were liberated from prisons in Greece using crewed helicopters.

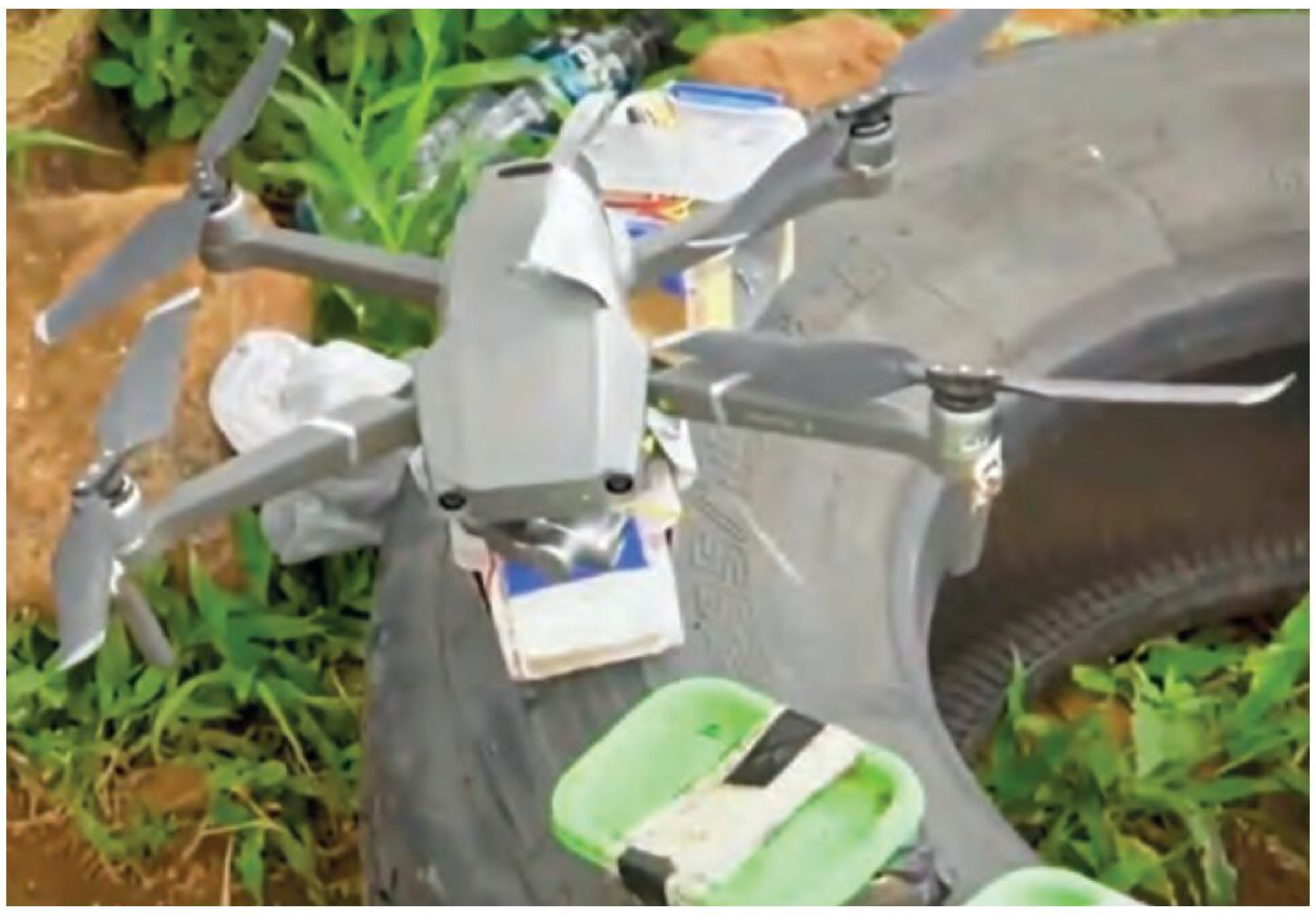


This home-made drop mechanism was recovered by the Richmond City Sheriff's Office in Virginia. It was found on the jail roof, attached to a DJI Phantom. There was no evidence that the aircraft had actually succeeded in delivering any contraband. (Image courtesy of the Richmond City Sheriff's Office)

This drone was recovered by agents from the United States Bureau of Prisons after it was used in an attempt to deliver contraband. (Image courtesy U.S. Bureau of Prisons)

Explosives Delivery. Small, consumer drones have also been used increasingly as weapons of war, being a low-cost means of delivering an explosive payload with pinpoint accuracy. The aircraft can either fly over the target and drop the explosive, or simply fly into the target and explode on impact—the latter approach being known as a "suicide drone."

The past year has seen increasing innovation in this area. First among these is electronic remote detonation, allowing the explosives to be triggered from the ground-control station, rather than relying on the force of an impact to cause detonation. Another new approach are so-called "sticky bombs" that use magnets to cling to vehicles or other metallic targets before exploding, in order to inflict maximum damage.



Recovered by Mexican authorities in Tepalcatepec, Michoacán, this DJI Mavic was fitted with C4 explosives and ball bearings packed inside a plastic food container by members of the Jalisco New Generation Cartel, for use in an attack on the city. (Image courtesy of the armed forces of Mexico)

Explosives carried by drones have also been paired with supplemental munitions to increase their lethal potential. One example is a plastic food container filled with ball bearings and nails attached below the explosive charge, which rain down as shrapnel on unprotected persons in the area.

Finally, similar to contraband delivery in prisons, heavy-lift drones can be used to ferry weapons, ammunition and explosives across national borders, for use by allied militants fighting government forces in a neighboring country.

UNLAWFUL SURVEILLANCE

Criminal Reconnaissance. The ability of drones to capture a real-time aerial perspective of events happening on the ground makes them valuable tools for first responders. However, that same capability can employed by criminals to nefarious ends. As an example, DroneSec cites the use of drones by gangs in Nakuru County, Kenya, to monitor the activities of local law enforcement while they commit crimes elsewhere—while disguising their flights as legitimate newsgathering operations.

"We have received information that the gang is now using drones to carry out criminal activities," stated Nakuru County Commissioner Erustus Mbui in local media reports. "Security agencies have taken that challenge seriously."

In Spain, enterprising burglars have begun using drones to scout the homes of professional soccer players while they are away at a game. If the drone determines that nobody is at home, the criminals move in and ransack the property.

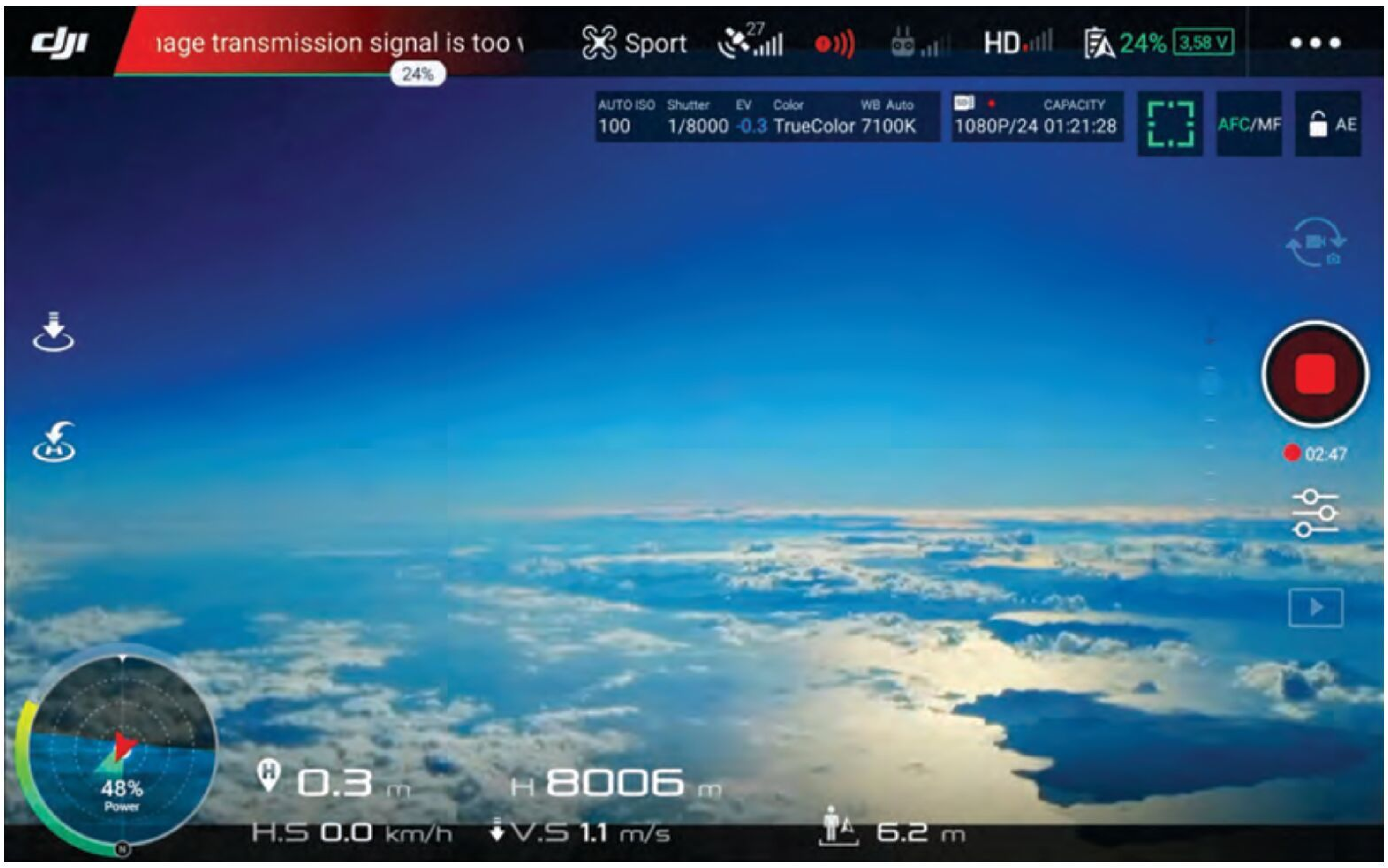
Vicenc Guillen of MARS Intelligence Security Consultants told the Marca sports news website, "Now threats come in the air. High fences, security guards and cameras aren't enough. We've had several players who have spotted drones over their houses, but we're certain that there are even more who haven't seen them. They're not easy to see because they're small, they can be very high up and even take advantage of darkness at night."

To combat the threat, MARS deploys a C-UAS system to detect and identify drones that approach the player's property, determine where the pilot is located and then hand over the information to local law enforcement.

Professional soccer players in Spain have contracted with MARS Intelligence Security Consultants to provide C-UAS coverage of their homes while they are away at a match, as a hedge against thieves using drones to scout their property ahead of a burglary. (Image courtesy MARS Intelligence)

Military Propaganda. Militants have taken advantage of the ability of small drones to livestream video directly to social media platforms to distribute real-time propaganda from the front lines. DroneSec documented one such instance during the fighting between Armenia and Azerbaijan late last year. The Azerbaijani military pushed live video of an attack being carried out by its forces to digital billboards in the capital city of Baku.

Looking ahead, DroneSec anticipates that this same tactic could be used by terrorists to bring attention to their exploits, magnifying the potential impact of their actions.



This frame capture reveals the moment that a drone pilot in Greece flying a modified DJI Mavic Pro Platinum crossed above 8,000 meters—more than 26,000 feet above ground level and well into the domain of commercial jetliners.

DRONE MODIFICATIONS

Anti-Forensics Measures. By using a drone to commit bad deeds, criminals and terrorists hope to keep themselves safe from the consequences of their actions. However, if a forensic examination of the drone itself reveals information about its operator, this advantage is lost. Therefore, illicit operators have begun taking steps to reduce the chances that the aircraft will be traced back to them after the fact.

Specific measures include:

- Wiping down the aircraft prior to flight, to remove fingerprints;
- Removing internal-caching and flight-data records;
- Disabling return-to-home capabilities;
- Defacing the serial numbers on the aircraft and the battery;
- Purchasing drones from untraceable, second-hand sources; and,
- Using custom mobile apps to control the aircraft, rather than the one developed by the manufacturer.

Although DroneSec was necessarily vague with the details, in order to protect their sources and methods for gathering this intelligence, it reported being a direct eyewitness to the sale of DJI user accounts to a third party, thereby preventing the ultimate buyer from being identified within the manufacturer's database.

Disabling Security Features. There are entities in Russia and elsewhere that provide customers with hacking tools that allow the end user to overcome many of the limitations embedded within commercial off-the-shelf drones. These include bypassing no-fly zones and exceeding limits on speed, range and altitude, as well as other safeguards.

Those capabilities can be further enhanced through the use of custom-made battery extensions, which can double or triple the flight time of these aircraft—while simultaneously increasing the risk of a fire or explosion.

Such tools have allowed illicit drone pilots to commit flagrant violations of national and international aviation regulations. In one instance reported in Greece, an operator succeeded in flying a DJI Mavic Pro Platinum to an altitude in excess of 26,000 feet—and captured video to prove it. As another example, DroneSec cites the case of pilot who flew a DJI drone from Singapore to the Raiu Islands off the coast of neighboring Indonesia, a distance of more than 11 miles.

THE FUTURE

As it has been since the beginning, each new invention of the human mind has the ability to be used for good or evil. A criminal can use a knife to kill an innocent victim, while the same instrument in the hands of a surgeon can save a life. The mighty power of atomic fusion, which can turn a city to ash in an instant, may someday soon be harnessed to provide limitless clean electric power.

In that regard, drones are no different than any other piece of technology. The list of their beneficial applications grows daily, and we are right to celebrate that fact and encourage their continued development. However, it is also good to remember that as the tower of our achievement climbs ever higher, so does the shadow it casts on the ground below.

DRONE SEC
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This briefing is presented with the support of DroneSec, a private intelligence firm based in Australia and Singapore. For more information, visit dronesec.com.

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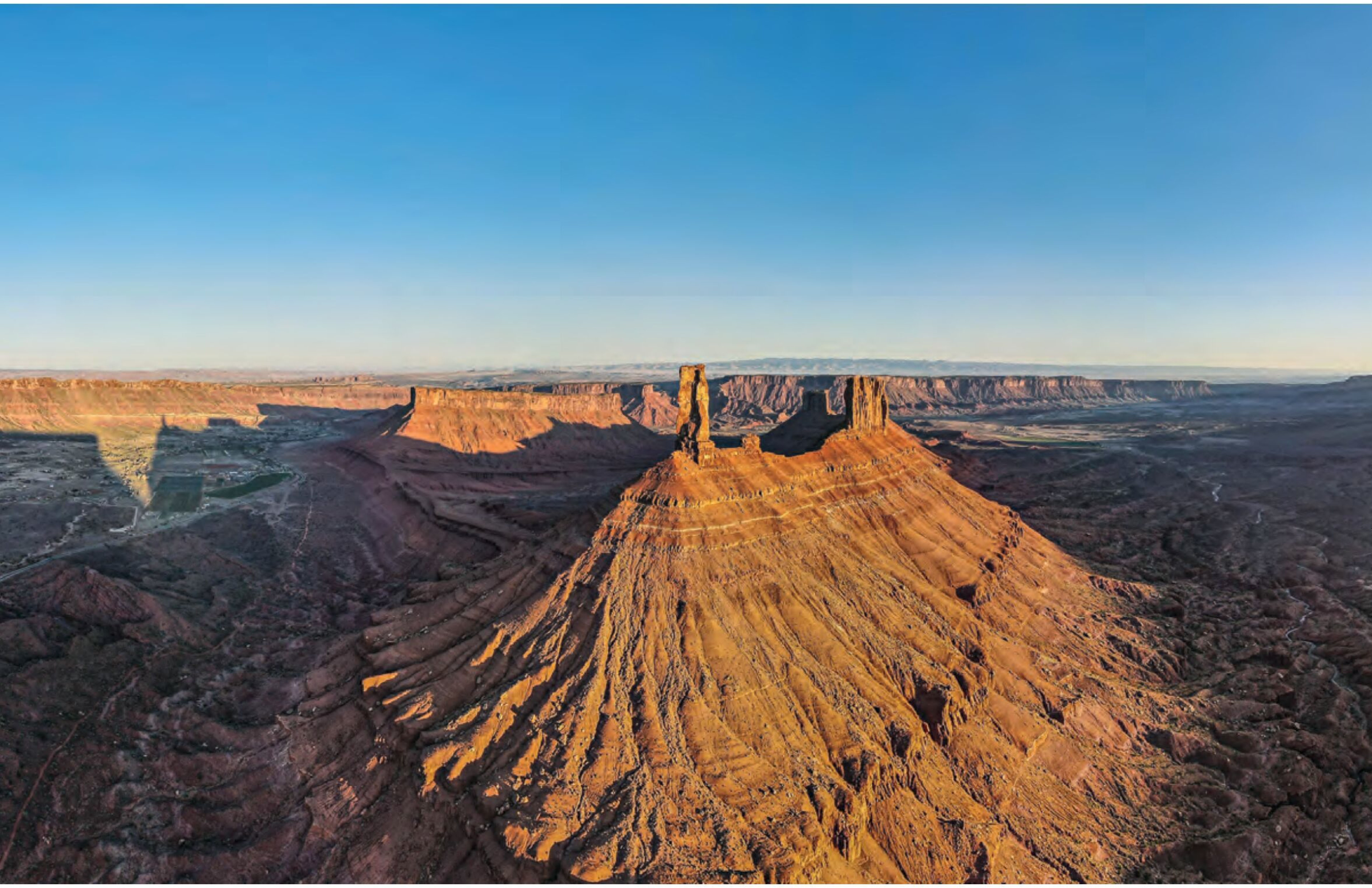

Desert Castles

Location: Moab, Utah

Pilot: Matthew Marcusen (@arcusen_aerial_photography)

Drone: DJI Mavic Air 2

SEND US YOUR PHOTOS If you have an image that you've taken with a multirotor that you'd like to see showcased in "Over the Horizon," please send your high-resolution image, your Instagram handle (if applicable), and information on the location and the drone you flew to capture the image to **RotorDrone@AirAge.com.** Every photographer we feature on this page will receive a free one-year subscription or extension to *RotorDronePro* magazine.

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